ence Abstracts

Section A

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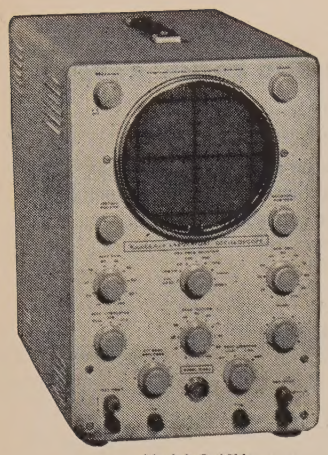

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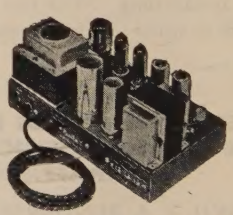

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Mean Forward Current at 25°C:	90 milliamperes
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°C ambient temperature	CG80H	CG81H	CG82H	CG83H	CG85H
inverse voltage V	100	75	50	25	12
forward current mA	70	75	77	80	90
(averaged over any 20 ms period) mW	100	110	110	110	114

ward Characteristics

°C ambient temperature		CG80H to CG83H		
ard current	mA	10	30	100
ge drop. Typical	V	0.375	0.50	0.8
Maximum	V	0.45	0.65	1.1

		CG85H
ard current	mA	40
ge drop. Maximum	V	0.6

rse Characteristics		CG80H	CG81H	CG82H	CG83H	CG85H
I.V.	V	100	75	50	25	12
cal inverse nt at 25°C	μA	30	38	20	12	—
at 60°C	μA	150	180	120	75	—
mum inverse nt at 25°C	μA	100	75	50	25	12
at 60°C	μA	500	300	250	150	38

citance Typical production spreads measured at –1 volt are as follows: Minimum 1.1 pF; Typical 1.8 pF; Maximum 3.0 pF.

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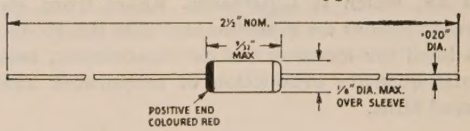

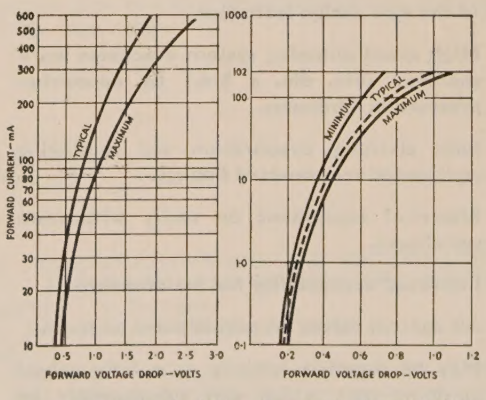

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Forward characteristic CG84H to CG85H

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PHYSICS ABSTRACTS

Volume 64 JULY 1961 Number 763

MATHEMATICS

7966 PARTIAL DIFFERENTIAL EQUATIONS AND CONTINUUM MECHANICS. Edited by R.E.Langer. Madison : University of Wisconsin Press (1961) x v + 397 pp. [Proceedings of an International Conference conducted by the Mathematics Research Center at the University of Wisconsin, Madison, June 7-15, 1960].

Consists of the nineteen lectures delivered at an international conference conducted by the Mathematics Research Centre at the University of Wisconsin from 7 to 15 June 1960. In addition to the lactures the book contains abstracts of forty-five papers presented at the conferences. Among the subjects covered in the conference were: Differential equations of mathematical physics, eigenvalue problems, elasticity, fluid mechanics, magnetofluid mechanics and statistical mechanics.

7967 APPROXIMATE CALCULATION OF ROOTS BY RATIOS OF POLYNOMIALS. F.Franke.
Jenaer Jahrbuch (Germany), 1959 II, 480-95. In German.

If b is an approximation to the n-th root of z, and $d = z - b^n$ then $z^{1/n} = bR(db^{-n})$ where

$$R(x) = \sum_{\nu=0}^{\infty} \binom{n-1}{\nu} x^{\nu}.$$

The author expresses R(x) as a continued fraction, and obtains formulae for the sum R(x) up to various orders of accuracy, as the ratio of polynomials in z and b. Explicit formulae are given for the first five approximations, for the special cases n = 2, n = 3 the ninth and eleventh approximations are studied. The use of this method in extracting square roots in digital computers is also discussed. N.L.Johnson

7968 ACCURATE AMPLITUDE DISTRIBUTION ANALYZER COMBINING ANALOG AND DIGITAL LOGIC.
T.A.Brubaker and G.A.Korn.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 317-22 (March, 1961).

A new precision analyser yields digital readout of probability or probability density for random waveforms at low audio frequencies. A preamplifier-limiter conveniently increases a half-volt slicing interval to 20 V or more, and a sample-hold circuit permits the slicer to work slowly and accurately. The use of analogue computer techniques permits convenient assembly of such instruments from inexpensive commercial plug-in amplifiers and decimal counters. Some statistical theory is also presented.

COUPLED INTEGRAL EQUATIONS OF THE OMNÉS–MUSKHELISHVILI TYPE. See Abstr. 7205

TABLE OF TWO-CENTRE INTEGRALS. See Abstr. 7451

7969 A POWER SERIES EXPANSION OF THE MASTER EQUATION. N.G.van Kampen.
Canad. J. Phys., Vol. 39, No. 4, 551-67 (April, 1961).

In order to solve the master equation by a systematic approximation method, an expansion in powers of some parameter is needed. The appropriate parameter is the reciprocal size of the system defined as the ratio of intensive and extensive variables. The lowest approximation yields the phenomenological law for the approach to equilibrium. The next approximation determines the mean square of the fluctuations about the phenomenological behaviour. In equilibrium this approximation has the form of a linear Fokker–Plank equation. The higher approximations describe the effect of the non-linearity on the fluctuations, in particular on their spectral density. The method is applied to three examples: density fluctuations, Alkemade's diode, and Rayleigh's piston. The relation to the expansion recently given by Siegel is also discussed.

7970 MEASUREMENT OF NOISE POWER SPECTRA BY FOURIER ANALYSIS. A.Z.Akcasu.
J. appl. Phys. (USA), Vol. 32, No. 4, 565-8 (April, 1961).

The theory of the direct Fourier analysis with finite sampled data is developed. Formulae for planning a measurement for a specified resolution and accuracy are obtained. A quantitative comparison with autocorrelation analysis is given. It is shown that direct Fourier analysis can be applied equally well to attain comparable resolution and accuracy with the same amount of data. The computer requirements are also comparable in both cases.

CLUSTER SIZE IN RANDOM MIXTURES AND PERCOLATION PROCESSES. See Abstr. 7512

ASTROPHYSICS

7971 TRANSFORMATION OF PHOTOGRAPHIC MAGNITUDES. H.Arp.
Astrophys. J. (USA), Vol. 133, No. 3, 869-73 (May, 1961).

Transformation equations are determined semi-empirically between the B system and photographic magnitudes obtained: (1) with 103a-O plates and aluminized reflectors, using only the atmosphere as an ultraviolet cutoff filter; (2) with 103a-O plates taken with the 48 in. Schmidt corrector plate as a filter (Sky Survey photographic system); (3) 103a-O plates with a WG2 or equivalent GG1 filter (a system used after the introduction of aluminized reflectors to approximate the original international photographic system).

7972 COMPARATIVE RESULTS OF PHOTOELECTRIC PHOTOMETRY AND PHOTOGRAPHIC SPECTRO-PHOTOMETRY. L.Houziaux.
Bull. Soc. Roy. Sci. Liege (Belgium), Vol. 30, No. 1-2, 91-6 (1961). In French.

Photoelectric observations of the star HD 50138 at wavelengths of 3062, 4237, 4965, 5665, 7597 and 9814 A, made with a six-colour photometer and corrected for atmospheric extinction, are compared directly with spectrophotometric measures of the same star, reduced and corrected for extinction following Chalonge's method. The two techniques yield discordant values that do not appear to be caused by a lack of proper corrections for extinction. It appears

that the response of the photocell through the narrow-cut filters is not the same as that obtained using the conventional spectrograph and photographic plate over equivalent spectral wavebands.

D.R.Barber

7973 AN INTENSITY RECORDING MICROPHOTOMETER AND THE RECORDING OF THE U.V. SOLAR SPECTRUM. G.Brückner.

Z. Astrophys. (Germany), Vol. 51, No. 3, 187-200 (1961). In German.

A microphotometer for scanning photographic plates is described. The photometer transforms automatically photographic densities into intensities. For this purpose the calibration curve is stored electrically in the photometer. The density of the photographic plate is measured in the usual way by a multiplier and is recorded by a compensating recorder. The potential drop at the measuring resistor of the recorder is distorted by twenty potentiometers, wired parallel to the resistor in such a way that the calibration curve is approximated by a polygon. The photometer was used to record exposures of the ultraviolet solar spectrum ($2988\ A \leq \lambda \leq 3600\ A$), taken at a solar telescope with a concave grating spectrograph.

7974 AN ANALYSIS OF R.A.LYTTLETON AND H.BONDI'S THEORY OF "THE PHYSICAL CONSEQUENCES OF A GENERAL EXCESS OF CHARGE". W.F.G.Swann.

Astrophys. J. (USA), Vol. 133, No. 3, 738-54 (May, 1961).

In Abstr. 3406 of 1960 a theory of relative galactic motions was developed leading to a velocity proportional to the distance from the assigned origin. The theory rests upon a spontaneous creation of matter and accompanying charge, in which the positive charge created exceeds, slightly, the negative. They set up field equations modified from the Maxwell–Lorentz form in such fashion as to permit of such charge creation by providing for a violation of the equation of continuity. However, the solution which they evolve for these equations and regard as applicable to the situation is one in which the electric field is zero, so that there is no force to accelerate the matter with its accompanying charges against the force of gravity. They seem to imply that the field equations themselves take care of this matter. However, it is here maintained, and is readily shown, that this cannot be so. The equation of non-continuity evolved from the modified field equations demands the form of motion involved in the velocity–distance law, but no finite field exists to provide for it. To provide for the motion, some motivating agency is necessary. Indeed, Lyttleton and Bondi's preliminary treatment of the problem sets up a picture in which the excess charge provides a repulsive force which exceeds the gravitational attraction and so provides for the motion, but they appear to regard this picture as purely provisional, to be replaced by a more subtle formulation born of the modified electromagnetic equations. In a later section of their paper they formulate the problem on the basis of the general theory of relativity, in order to secure harmony with the cosmological principle to the effect that the universe, apart from local irregularities, looks the same to all observers regardless of where they may be stationed in it. Again the proportionality between v and r appears, but it is here maintained that it does not appear as something provided for by the field equations, but as a relation which can be realized only by appeal to the law of the geodesic as the motivating agency responsible for the motion, a motion, moreover, which the de Sitter line element is so well fashioned to provide. However, it remains to provide a basis for the de Sitter line element. This the authors achieve only through the introduction of an electromagnetic energy tensor which has no apparent relation to classical electrodynamics, non-relativistic or relativistic, and can only be said to be designed with no background but in such a manner as to achieve the end desired. The ultimate conclusion is that the relativistic treatment cannot be regarded as a mere generalization of the non-relativistic treatment, as the authors seem to imply.

7975 OSCILLATIONS OF ROTATING COSMICAL BODIES IN THE PRESENCE OF MAGNETIC FIELD.

J.N.Tandon.

Indian J. Phys., Vol. 34, No. 3, 107-17 (March, 1960).

The effect of rotation on the radial pulsations of cosmical fluid masses with special reference to spherical mass (magnetic variables) and cylindrical mass (spiral arm, solar-ion stream) was investigated when the fluids have volume electric currents. Two models of current systems are considered for cylindrical mass: circular currents and line currents. It is found that for radial pulsations, rotation in general, helps in the dynamical stability of the cosmical bodies.

7976 SINGULARITIES OF THE COSMOLOGICAL SOLUTIONS OF GRAVITATIONAL EQUATIONS.

I.M.Khalatnikov, E.M.Lifshitz and V.V.Sudakov.

Phys. Rev. Letters (USA), Vol. 6, No. 6, 311-13 (March 15, 1961).

It is concluded that: "the existence of a physical time singulari is not an obligatory property of the cosmological models of general relativity". The singularities known to arise in "synchronous", i.e. geodesic normal, coordinates may in general be mere coordina singularities (cf Abstr. 1043 of 1957). F.A.E.Pira

ON THE ORIGIN OF COSMIC MAGNETIC FIELDS. See Abstr. 8335

7977 A STUDY OF NEUTRAL HYDROGEN IN A REGION IN CYGNUS. M.A.Kaftan-Kassim.

Astrophys. J. (USA), Vol. 133, No. 3, 821-42 (May, 1961).

In a region in Cygnus ($35^0 \leq l \leq 60^0$, $-10^0 \leq b \leq +10^0$), observ tions of 21 cm line profile of neutral hydrogen have yielded the following results: (a) The densities of neutral hydrogen in the optically obscured region of the Great Rift are greater than in the relatively clear areas, the ratio of gas to dust densities varying between 38 and 105. (b) The neutral hydrogen densities increase at the positions of the O-B associations. Also, evidence is found for a expanding HI region around the association VI Cygni. (c) The derived motion of the neutral hydrogen agrees more closely with Weaver's galactic rotation-curve than with Schmidt's.

7978 THE KINEMATICS OF THE LOCAL GAS SYSTEM. H.L.Helfer.

Astron. J. (USA), Vol. 66, No. 4, 160-8 (May, 1961).

Some features of the 21 cm velocity measurements of hydroge gas for $|b| \geq 20^0$ are analysed. An argument is presented for consideration of an expression for the residual velocity–distance rela tion of the form

$$\text{R.V. (km/sec)} = 1.24 \cos l^{\text{I}} \cos b^{\text{I}} + 2.62 \sin l^{\text{I}} \cos b^{\text{I}} - 1.60 \sin b^{\text{I}}$$

$$-Sr\{1-[1.1 + \sin 2(l^{\text{I}} + 53^0)] \cos^2 b^{\text{I}} + 0.25 \sin(l^{\text{I}} - 48^0) \sin 2b^{\text{I}}\},$$

where r is the distance and S is an unknown (positive) scale facto Crude arguments suggest $S \sim 10$ km sec^{-1} kpc^{-1}. Some implication of these numerical values and of the assumption that the local gas system is associated with the stellar Gould's belt system are brief discussed.

COLLISION OF TWO INTERSTELLAR GAS CLOUDS, SHOCK-WAVE MODEL. See Abstr. 8328

7979 LUNAR SURFACE CHARACTERISTICS INDICATED BY THE MARCH, 1960, ECLIPSE AND OTHER OBSERVATIONS. J.E.Gibson.

Astrophys. J. (USA), Vol. 133, No. 3, 1072-80 (May, 1961).

The variation in lunar brightness temperature during the total eclipse of March 13, 1960, was found to be about 1^0 or less at 8.6 r wavelength. This result, when combined with prior data for this a other wavelengths, indicates that the average, or typical, lunar surface structure is stratified in at least two, and possibly three, layers. The topmost layer is about 0.5 cm in depth and seems to resemble ordinary sand in vacuo, the intermediate layer may be several centimeters or more in depth and is most notably characterized by a high electric conductivity, while the lowermost stratu of indefinite depth is more like rock.

7980 DENSITY OF THE LUNAR ATMOSPHERE. E.J.Öpik and S.F.Singer.

Science (USA), Vol. 133, 1419-20 (May 5, 1961).

The consequences of a model are worked out in which the luna atmosphere is formed by gravitational accretion of interplanetary gas. The results differ from those of Firsoff and of Brandt, partly because of the inapplicability of the barometric equation to the case of an exosphere. (See Abstr. 6701-3 of 1961).

7981 ACTIVITY OF COMETS' TAILS DURING PERIODS OF GEOMAGNETIC INACTIVITY. R.Lüst.

Z. Astrophys. (Germany), Vol. 51, No. 3, 163-76 (1961). In German.

It is investigated whether the gaseous, ionized cometary tails (Bredichin's type I) show pronounced activity and fast changes in structure during periods of low geomagnetic disturbance. This question is interesting with regard to the nature of interplanetary matter. If interplanetary matter is identical with the particle stre

emitted by the sun, as has been assumed recently, there must be a continuous particle emission even in times of low solar activity. Four comets have been found which possessed ionized tails showing rapid and continuous changes of structure during extended periods of extremely low geomagnetic activity, thus supporting the aforementioned assumption. These four comets are discussed in detail. An example of a very strong correlation between tail activity and geomagnetic storms is given. Observations of Comet 1899 I indicate two explosion-like events succeeded by heavy tail activity. The time between these two events corresponds exactly to one solar rotation as seen from the comet, and both events can thus be attributed to the same persistent source of particle emission on the sun which showed up in the geomagnetic data of this period. The time lag between the geomagnetic disturbance and the event on the comet indicates a velocity of the solar particle stream of about 300-400 km/sec which is lower than the velocity observed during periods of enhanced solar activity (about 1000 km/sec).

7982 Ne IN SOME STONE METEORITES.
P.Eberhardt and A.Eberhardt.
Z. Naturforsch.(Germany), Vol. 16a, No. 3, 236-8 (March, 1961).

Ne^{20}, Ne^{21} and Ne^{22} were measured in several stone meteorites. Good agreement with other cosmic-ray produced rare gas isotopes was obtained. No indication of primeval neon was found in the chondrites, but one urelite showed excess Ne^{20}.

7983 GENERAL MAGNETIC FIELD OF THE SUN—BASED ON MAGNETOGRAMS. I. I.K.Csada.
Acta phys. chem. Szeged.(Hungary), Vol. 5, No. 1-2, 12-19 (1959).

Values of $\bar{H}_X$, the mean radial component of the solar magnetic field, are found by measuring, with a planimeter, the areas under magnetograms obtained by Babcock. From these, by least squares, the coefficients of the first two terms of the assumed analytical expansion for $\bar{H}_X$ are calculated and the principal unknown in the expansion, a dimensionless parameter h, determined. From 87 magnetograms taken between May 11 and December 12, 1954, h has a mean value of about 0.4 (there are a few exceptional values) and shows a slight evidence of a periodic variation, with period 30 days.
G.A.Chisnall

MICROWAVE POLARIZATION AND CORONAL MAGNETIC FIELDS. See Abstr. 8023

7984 THE DISTRIBUTION OF TEMPERATURE IN THE NEIGHBORHOOD OF THE SOLAR LIMB. B.E.J.Pagel.
Astrophys. J. (USA), Vol. 133, No. 3, 924-34 (May, 1961).

The range of choice among temperature distributions put forward in a previous paper (Abstr. 2619 of 1961) is narrowed down by deriving electron temperature, density, etc., in the lowest 500 km above the limb from Kristenson's observations of the 1954 eclipse at λ 6190, taking self-absorption effects into account. The minimum temperature turns out to be $4300^\circ K \pm 100^\circ K$ and to occur very close to the limb ($\tau_\lambda = 0.007$), provided that the H^-:H ratio is in accordance with Saha's equation. It is not possible to represent completely both Dunn's disk observations and Kristenson's limb observations with a temperature distribution that follows the Pierce—Waddell formula for substantial optical depths, turns down to a minimum near the surface and then rises; two such distributions are derived, according to whether the greatest weight is placed on one set of measurements or the other. The two sets of measurements could be made compatible by adopting slightly higher temperatures than those given by the Pierce—Waddell formula in the range $0.03 < \tau_\lambda < 0.06$, but more measurements will be needed in order to make definite predictions on this.

7985 DEVELOPMENT OF AN ANOMALOUS SUN-SPOT GROUP. M.Waldmeier.
Z. Astrophys. (Germany), Vol. 52, No. 1, 1-6 (1961). In German.

From 26 March to 6 April, 1960, a sunspot-group was observed, which consisted of four main spots within the same penumbra, producing a twin group. This group was extremely active and greatly influenced the ionosphere, the activity of polar aurorae, the terrestrial magnetism, as well as the cosmic radiation. The flares preferably occurred along the boundary between the magnetic polarities. The behaviour of the group was anomalous with regard to its development, its geometrical configuration, its proper motions and its magnetic polarities. An attempt is made to interpret the behaviour of the group by assuming an extremely strong deformation of the vortex ring. Such a deformation can also be observed in normal groups, though in a much lower degree.

7986 FACULAR GRANULE LIFETIMES DETERMINED WITH A SEEING-MONITORED PHOTOHELIOGRAPH.
R.J.Bray and R.E.Loughhead.
Austral. J. Phys., Vol. 14, No. 1, 14-21 (March, 1961).

A telescope designed to take exposures automatically at moments of good seeing was used to obtain a $5\frac{1}{2}$ hr sequence of high quality photographs of a facular region near the east limb of the sun. Individual facular granules are found to be much longer lived than the photospheric granules, a result which agrees with the work of ten Bruggencate (1940) and Waldmeier (1940) but disagrees with the more recent observations of Macris (1953) and of Krat and Goldberg—Rogosinskaja (1956). 50% of the facular granules last for over 2 hr, and 10% last for over 5 hr. In some cases, a facular granule, only 750—1500 km in diameter, occurs as an isolated bright structure, surrounded by normal photosphere and well removed from neighbouring sunspots or faculae. Apart from their greater brightness and much longer lifetimes, the facular granules differ from the photospheric granules in that they do not form a well-defined cellular pattern; these differences suggest different modes of origin. A description is given of the method of triggering the exposures by means of a seeing monitor.

7987 THE SUN.
M.A.Ellison.
Discovery (GB), Vol. 21, No. 1, 6-11 (Jan., 1960).

A popular account of the results on the solar flares and their effects obtained during the I.G.Y. and later.

7988 SYMPOSIUM ON THE JULY 1959 EVENTS AND ASSOCIATED PHENOMENA, HELSINKI, JULY 1960.
Paris: Union Géodésique et Géophysique Internationale (Nov., 1960) 157 pp. [Monographie No. 7].

Abstracts of the papers will be published in later issues of Physics Abstracts.

7989 IMPULSIVE PHENOMENA OF THE SOLAR ATMOSPHERE. I. SOME OPTICAL EVENTS ASSOCIATED WITH FLARES SHOWING EXPLOSIVE PHASE.
R.G.Athay and G.E.Moreton.
Astrophys. J. (USA), Vol. 133, No. 3, 935-45 (May, 1961).

A new class of optical phenomena of the solar atmosphere associated with flares is described. These phenomena are characterized by high velocities (≅ 1500 km/sec) and shorter time scales than has been indicated by previous observations. An explanation of some of the observed phenomena is offered in terms of corpuscular streams ejected from flares at the time of an "explosive phase" occurring during the rise to maximum brightness.

7990 ON THE INTERPRETATION OF PROMINENCE SPECTRA. II. THE LINE AND CONTINUOUS SPECTRUM OF THE SPRAY-TYPE LIMB EVENT OF MARCH 7, 1959.
J.T.Jefferies and F.Q.Orrall.
Astrophys. J. (USA), Vol. 133, No. 3, 946-62 (May, 1961).

For Pt I, see Abstr. 7743 of 1959. The line and continuum emission of a limb flare of March 7, 1959, are discussed. An analysis of the continuum emission near the Balmer limit shows that the kinetic temperature of the flare must be considerably less than $20\,000^\circ K$ in that region where the hydrogen is excited. On the assumption that the hydrogen emission is axially symmetric, a model is derived for the temperature, electron density, and gas pressure as a function of distance from the axis. The temperatures so derived are much lower than those obtained from the usual methods of line-width analysis, which, it is suggested, are of questionable value in application to active limb events.

7991 ON THE INTERPRETATION OF PROMINENCE SPECTRA. III. THE LINE AND CONTINUOUS SPECTRUM OF A LOOP PROMINENCE AND LIMB FLARE.
J.T.Jefferies and F.Q.Orrall.
Astrophys. J. (USA), Vol. 133, No. 3, 963-8 (May, 1961).

For Pt II see preceding abstract. A detailed photometric study is presented of the line and continuous spectrum of the limb flare of June 9, 1959. The electron temperature is found to be certainly less than $24\,000^\circ K$ in the bright, dense central portion of the flare, where the hydrogen lines and continuum are excited. The flare occurred as a condensation in an active coronal region, yet the temperature is only slightly higher than that observed in a spray-type flare that originated at the chromospheric level. Temperatures of $10\,000^\circ$ and $20\,000^\circ K$, respectively, are tentitively suggested for "cool" and "hot" prominence classes suggested by Zirin and Tandberg-Hanssen.

7992 DISTRIBUTION OF HEIGHTS OF PROMINENCES. R.Ananthakrishnan.
Astrophys. J. (USA), Vol. 133, No. 3, 969-72 (May, 1961).

Study of the frequency distribution of heights of nearly 50 000 prominences observed on K-spectroheliograms during a complete solar cycle shows a nearly exponential decrease of frequency with increasing height between 20" and 220" of height above the chromosphere.

7993 CORONAL EMISSION IN THE VICINITY OF QUIESCENT PROMINENCES.
N.K.Williamson, C.M.Fullerton and D.E.Billings.
Astrophys. J. (USA), Vol. 133, No. 3, 973-7 (May, 1961).

Lambda 5303 emission is diminished in the presence of quiescent prominences, but by a somewhat smaller amount than is predicted from the gross geometry of the prominences.

7994 THE SOLAR CORONA IN ACTIVE REGIONS AND THE THERMAL ORIGIN OF THE SLOWLY VARYING COMPONENT OF SOLAR RADIO RADIATION. G.Newkirk, Jr.
Astrophys. J. (USA), Vol. 133, No. 3, 983-1013 (May, 1961).

Using as a basis previously published K-corona observations made at Climax, Colorado, a model is derived for the enhancement of electron density in the corona above an active region. The electron densities in the quiet corona during the sunspot maximum 1957-1958 were found to be about twice those reported by van de Hulst for a maximum corona, while densities along the axis of the active region were found to be about twice those in the quiet corona at the same height. The several models advanced in the past to explain the slowly varying component of solar radio radiation are criticized mainly on the basis that they require coronal temperatures of from 6 to 10×10^6 °K, while there is no evidence for the existence of such temperatures. The electron densities determined in the first section are combined with models of the chromosphere and of a plage to determine the appearance of the active region at radio wave lengths. Detailed calculations of the appearance of the active region at various radio frequencies were carried out and include the effect of refraction but neglect the effect of magnetic fields. Profiles of the solar disk at various radio frequencies for three coronal models with the active region at various positions on the solar disk are presented. These profiles are then used to predict such characteristics of the slowly varying component as its spectrum, apparent size, "height", and directivity. The comparison of these predictions with the observed properties leads to the conclusion that the slowly varying component is due solely to the enhancement of densities in the corona and in the chromospheric plage. There is no evidence that the temperature of the corona is modified from its normal value of about 2×10^6 °K. A brief examination of the thermal radiation from an idealized loop prominence shows that temperatures of $3\text{-}4 \times 10^6$ °K are sufficient to explain some of the features of the radio event called "gradual rise and fall".

7995 SUDDEN EXPANSION OF THE CORONA FOLLOWING A LARGE SOLAR FLARE AND THE ATTENDANT MAGNETIC FIELD AND COSMIC-RAY EFFECTS. E.N.Parker.
Astrophys. J. (USA), Vol. 133, No. 3, 1014-33 (May, 1961).

It is shown from the hydrodynamic equations that the 4×10^6 °K temperatures observed in the solar corona after a large solar flare can produce a hydrodynamic blast wave, moving out through interplanetary space with velocities of 1500 km/sec and densities from a few times 10^2 cm^{-3} to 10^5 cm^{-3} at the orbit of earth. This hydrodynamic explosion of the enhanced corona is proposed as being the "accelerating mechanism" for the "plasma clouds" or "enhanced solar corpuscular emission" responsible for the geomagnetic storm, the cosmic-ray decrease, the low-latitude aurorae, etc., observed at earth a day or two following large solar flares on the visible hemisphere of the sun. The interplanetary magnetic field in the blast wave is computed assuming an initial quiet-day solar wind of a few hundred km/sec ahead of the wave. The spiral field of the quiet-day wind is sheared by the blast wave, and its density, of the order of 2×10^{-5} gauss at the orbit of earth, may be increased to 5×10^{-4} gauss or more for a period of several hours. The effect of the outward-sweeping magnetic shear in the blast wave is to decrease the cosmic-ray intensity, occasionally perhaps by as much as 40%, in the inner solar system behind the blast wave. The onset of the decrease has a characteristic time of several hours, and the relaxation many hours or days. The energy dependence of the decrease may go inversely with particle rigidity, or it may be flatter, depending on the details of the magnetic configuration in and around the blast wave. Thus the cosmic-ray decrease produced by the blast wave is identical with the Forbush-type cosmic-ray decrease observed in association with "enhanced solar corpuscular radiation." Thus, besides produced the observed 1500 km/sec ejection of matter from the sun responsible for the geomagnetic storm, the hydrodynamic expansion of the enhanced corona produces the observed Forbush decrease. It is suggested therefore, that the simple dynamical model of the enhanced corona developed in this paper is not unlike that which actually occurs following a large solar flare.

7996 CAPE LYOT HELIOGRAPH RESULTS. I. LIGHT-CURVES OF 30 SOLAR FLARES IN RELATION TO SUDDEN IONOSPHERIC DISTURBANCES.
M.A.Ellison, S.M.P.McKenna and J.H.Reid.
Dunsink Obs. Publ. (Ireland), Vol. 1, No. 1, 3-36 (rec., 1961). 1961).

An account is given of the Lyot Hα Heliograph, installed at the Royal Observatory, Cape of Good Hope, for the purposes of the International Geophysical Year. Photometric methods are described which were designed for the plotting of light-curves of solar flares from the exposures made at 1 min intervals on 35 mm film. Thirty flares were selected on the criterion of the completeness of the records of their ionospheric effects. Light-curves for these flares together with their measured areas, are reproduced alongside the records of the sudden ionospheric disturbances (short wave fade-outs, sudden enhancements of atmospherics and geomagnetic crochets). Delays of the order of 6 min are again found between the times of flare maximum in Hα and the intensity peaks of the fade-outs and sudden enhancements of atmospherics. A discussion of the origin of these time delays suggests that they arise mainly from "relaxation" times in the various ionospheric levels and that the emission of the ionizing radiation from the sun is probably simultaneous with that of the observed Ha radiation. For the crochets the time-lag is of the order of 2 min and the total duration of the crocket is less than one-half that of the other S.I.Ds. The bearing of these facts upon the ionospheric level of the crocket current is considered. Families of flares occurring successively in the same solar active region and possessing many characteristics in common are described. Their importance for a fuller understanding of the flare mechanism is emphasised and it is proposed to call them homologous flares.

7997 CAPE LYOT HELIOGRAPH RESULTS. II. THE 3+ FLARE OF 1960 JUNE 1 AND ITS INFLUENCE ON THE Ha STRIATION PATTERN.
M.A.Ellison, S.M.P.McKenna and J.H.Reid.
Dunsink Obs. Publ. (Ireland), Vol. 1, No. 2, 39-49 (rec. May 2, 196

An analysis is made of the development of an outstanding flare base upon a complete film record taken at 1 min intervals with the Lyot Hα Heliograph. Light-curves are plotted for the three brightest flare filaments. These all show a flash of radiation occurring at about 0840 U.T., coinciding in time with the beginning of a severe sudden disturbance in the ionosphere. The accompanying short wave fade-out had a duration greater than 8 hours. The bright filaments of the flare showed slow outward movements and speeds of these are deduced. The most remarkable feature was the radical transformation of the chromospheric striation pattern to the west of the flare which took place close to the time of maximum flare intensity. This phenomenon was similar to that which was reported previously in association with the Class 3 flare of 1960 April 1. This effect is attributed to a sudden change in the magnetic field which is thought to be reponsible for the alignment of the chromospheric striations. The redistribution of the magnetic field is believed to be brought about by the flash of the flare. The terrestrial effects of the flare are briefly summarised.

7998 CORRECTION FACTORS FOR THE PASSAGE FROM APPARENT AREA TO THE CORRECTED AREA OF BRIGHT FLARES IN HYDROGEN LIGHT. M C.Ballario.
RC Accad. Naz. Lincei (Italy), Vol. 29, No. 5, 330-5 (Nov., 1960). In Italian.

See Abstr. 2622 of 1961.

7999 COSMIC-RAY FLARE OF NOVEMBER 20, 1960. B.T.Hansen.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 260-2 (March 15, 1961).

The solar limb-flares of May 4 and of Nov. 20, 1960 had several features in common. Both were associated in their early stages with extremely rapid vertical movement of luminous material to

great heights above the solar surface. Also transverse velocities of up to 1000 km/sec were observed in expanding bright loops of prominence material. In both instances, large increases of cosmic-ray neutrons occurred during the lifetime of the visual flare event. The flare's ascent was followed by ionospheric disturbance that continued long after the visual event has terminated.

D.R.Barber

8000 EQUILIBRIUM MODELS FOR STARS WHICH DERIVE ENERGY FROM HELIUM-BURNING. I. STARS COMPOSED OF PURE HELIUM. J.P.Cox and R.T.Giuli.
Astrophys. J. (USA), Vol. 133, No. 3, 755-63 (May, 1961).

Equilibrium models are constructed for pure helium stars which derive all their energy production from the Salpeter triple alpha reaction. The Cowling model with an electron-scattering envelope is adopted as the basic model for the present calculation. Radiation pressure and degeneracy are both neglected. Integrations on an electronic computer have yielded the constants of the model to greater accuracy than has been reported previously. The assumptions of negligible radiation pressure and degeneracy are shown to limit the masses for which the present models are physically valid to the range $0.5 \leq M \leq 9$ (solar units). The assumption of pure electron scattering is also found to be fairly good for all masses considered. The helium-burning "main sequence" derived here runs roughly parallel to the normal population I main sequence and is displaced toward higher effective temperatures, for given luminosity, by a factor of about 4 relative to the population I main sequence. The present results are also compared with those obtained by Crawford (1953) on the basis of the standard model.

8001 EQUILIBRIUM MODELS FOR STARS WHICH DERIVE ENERGY FROM HELIUM-BURNING. II. HELIUM STARS WITH HYDROGEN-RICH ENVELOPES.
J.P.Cox and E.E.Salpeter.
Astrophys. J. (USA), Vol. 133, No. 3, 764-80 (May, 1961).

Models are constructed for helium stars which possess a hydrogen-rich envelope in radiative equilibrium. These inhomogeneous models are obtained from the models constructed in Pt I (see preceding abstract) for homogeneous, pure helium-burning stars by use of an approximation method. This method is applicable only if the fractions of the total mass and total energy production contained in the envelope are small. The bolometric luminosity is assumed to be the same as that of a homogeneous, pure helium star of the same mass M. If the hydrogen abundance X' (by weight) in the envelope is near unity, then the presence of a hydrogen-rich envelope containing a mass fraction Q' of only 0.1 is found to increase the radius of the star by a factor of about 10. The factor by which the radius is increased is independent of mass M but increases rapidly with both X' and Q'. The present approximate models are in good agreement with more accurate ones constructed by Hoyle and Schwarzschild (1955) for larger values of Q'. Assuming the O-type subdwarf HZ 44 to be represented by a model of this type, its mass and absolute bolometric magnitude can be estimated with the help of the data given by Münch (1958). It is found that $M \cong 0.5\ M_{\odot}$, $M_{bol} \cong +0.8$, and $Q' \cong 0.05$. The possible evolutionary significance of the present models and their relation to the observed properties of the nuclei of planetary nebulae and of the hot subdwarfs are briefly discussed. The approximation method is described in fairly general form and is applied to the pure helium star models of Pt I to show that inclusion of the free-free contribution to the opacity in the outer layers of these models would have increased their radii by no more than 2 or 3 per cent.

POSSIBLE GENERAL RELATIVISTIC EFFECTS IN WHITE DWARF STARS. See Abstr. 8039

8002 U–B AND B–V COLORS OF BLACK BODIES.
H.Arp.
Astrophys. J. (USA), Vol. 133, No. 3, 874-82 (May, 1961).

Standard U, B, V response-curves are adopted and are used to operate on 10 Planck curves which range in temperature from $T = \infty$ to $T = 3000^{\circ}K$. The same response-curves are used to compute the colours of the B star η UMa and the relatively line-free subdwarf HD 140283. The zero points of the system are thus set to give the same colours as the Johnson-Morgan U–B, B–V. The line which a black-body radiator would define in the U–B, B–V diagram is shown. It is computed that for a star of infinite temperature B–V = –0.46, U = –1.37 mag. would be observed. The approach of real stars to the black-body relation is discussed. The relation of some high-temperature central stars of planetary nebulae, measured by Abel, to the black-body line is shown.

8003 FLARE ACTIVITY ON YZ CANIS MINORIS.
P.E.Roques.
Astrophys. J. (USA), Vol. 133, No. 3, 914-19 (May, 1961).

Recent photoelectric observations of YZ Canis Minoris show the flare phenomena of dMe stars to be more complex than was originally realized. Deviations from the usual exponential fading from maximum brightness cannot be explained by simple radiation cooling of a heated area. Among small flares, no simple relationship seems to exist between amplitude and duration. The commencement of small variations in the brightness of a flare star may possibly be associated with the appearance of major flares.

8004 SPECTRAL CLASSIFICATIONS FOR NEW OR UNCLASSIFIED EMISSION-LINE, CARBON AND S, LONG-PERIOD VARIABLE, AND DOUBLE STARS.
J.J.Nassau and C.B.Stephenson.
Astrophys. J. (USA), Vol. 133, No. 3, 920-3 (May, 1961).

New spectroscopic data from objective-prism plates covering blue-ultraviolet and Ha spectral regions are presented for about sixty stars belonging to the categories defined in the paper title. Identification charts are given for two new long-period variables.

8005 SUPERNOVA IN NGC 7331.
H.Arp.
Astrophys. J. (USA), Vol. 133, No. 3, 883-94 (May, 1961).

On June 28, 1959, Humason discovered a bright supernova in the Sb galaxy, NGC 7331. A total of 81 photometric observations on the supernova over a span of 101 days in analysed. Photoelectric calibration is established, corrections for background light of the nebulae are made, and all observations are brought as accurately as possible onto the U, B, V system. The light-curve and all other properties identify the supernova as being of type II. The total reddening in front of the supernova, due both to the Galaxy and to NGC 7331, is estimated at about $E_{B-V} \sim 0.5$ mag. Using the redshift criteria for the distance of NGC 7331 yields, for the supernova near maximum light, $M_B = -19.1$ mag., $(B-V)^0 = -0.25$ mag., $T_e = 25\,000^{\circ}K$ $M_{bol} = -21.8$ mag. The nebula with this modulus has $M_{pg} = -21$ mag. The above temperature is derived from the colour index on the assumption of a discrete radiating shell. This assumption is roughly checked by the observations. The two-colour observations of the supernova indicate increasingly strong Balmer absorption for about 10 days after maximum taking place in an atmosphere with roughly the same electron pressure as a luminosity class I supergiant.

8006 STRUCTURE AND EVOLUTION OF GLOBULAR CLUSTERS. R.W.Michie.
Astrophys. J. (USA), Vol. 133, No. 3, 781-93 (May, 1961).

A three-parameter distribution function in terms of energy and angular momentum and with a cutoff at the energy of escape is used to describe the structure of spherical stellar systems. The corresponding density distribution for a specific set of parameter values is obtained numerically, and the result agrees very well with observations of 47 Tuc from 1 to 50 parsecs by Gascoigne and Burr. For large distances, $\rho(r)$ varies as $r^{-3.7}$, and the cluster therefore has a finite mass. In obtaining the evolution of a spherical cluster, the basic assumption is that the continuous evolutionary process can be approximated by a series of successive equilibrium states. Therefore, the distribution function is assumed invariant in form, and the problem is the calculation of the changes in the three parameters after a time interval Δt. This is done by taking three moments of the Boltzmann equation with the assumption of dynamical equilibrium during Δt. These moments represent the mass, the kinetic energy summed over all stars, and the angular momentum squared, also summed over all stars. An evolutionary time step of three-quarters of a billion years is obtained numerically with an IBM 650. The results show a flow of stars inward within 1 parsec from the centre and an expansion beyond 20 parsecs. The core of the cluster (within 1.6 pc from the centre) contracts. In the inner regions the mean-square velocity decreases, and beyond 20 pc the mean-square velocity increases. The isotropy of the distribution in velocity space increases in the inner regions and decreases for the outer sections at corresponding M_r. This result can be explained by a few stars suffering encounters and being thrown into orbits of high energy and low angular momentum.

8007 SPECTRA AND OTHER CHARACTERISTICS OF INTERCONNECTED GALAXIES AND OF GALAXIES IN GROUPS AND IN CLUSTERS. II. F.Zwicky and M.L.Humason.
Astrophys. J. (USA), Vol. 133, No. 3, 794-813 (May, 1961).

In continuation of the work reported in Pt I (Abstr. 2642 of 1961) an analysis was made of spectra and direct photographs, obtained

with the 200 inch Hale telescope, of four additional multiple galaxies whose members are interconnected by luminous filaments, bridges, and clouds. Symbolic velocities of recession for all the galaxies involved were determined, as well as their apparent dimensions and luminosities. Data are also given on the rotation of some of the galaxies. From the mentioned observed quantities, indicative absolute distances, dimensions, luminosities, and masses are derived. Finally, some values for the indicative mass-luminosity ratios of the systems discussed in both Pts I and II are given. For purposes of illustration one of the spectrograms is reproduced which shows the spectra of two galaxies and of two knots on the luminous bridge connecting them.

8008 USE OF THE BRIGHTEST GALAXIES IN A CLUSTER AS A DISTANCE INDICATOR. J.P.Massonie.
C.R. Acad. Sci. (France), Vol. 252, No. 10, 1426-8 (March 6, 1961). In French.

A theoretical discussion of the statistical problems involved. Since the real size of the sample must always be unknown, only an approximate solution is possible. This has been achieved by applying the statistical methods of Cramer (1945), and Scott (1957), and using the absolute magnitudes of the bright components of a cluster of galaxies as criteria of the distance modulus of the cluster. See also following abstract. D.R.Barber

8009 USE OF THE BRIGHTEST GALAXIES OF A CLUSTER AS A DISTANCE INDICATOR. APPLICATION.
J.P.Massonie.
C.R. Acad. Sci. (France), Vol. 252, No. 11, 1565-7 (March 13, 1961). In French.

The method developed in an earlier paper (see preceding abstract) is here applied to a determination of the distance moduli of three typical clusters. The result for one of these, the Coma cluster, is 30.6 — very close to Stebbins' value of 30.7.
D.R.Barber

8010 STRUCTURE AND EVOLUTION OF THE GALACTIC SYSTEM. V.C.Rubin.
Phys. Today (USA), Vol. 12, No. 12, 32-5 (Dec., 1960).

An account of an international summer course held from 28 July to 16 Aug., 1960 at Nyenrode Castle, Breukelen, Netherlands.

8011 ON THE EVOLUTION OF STELLAR SYSTEMS. V.A.Ambartsumian.
Quart. J. Roy. Astron. Soc. (GB), Vol. 1, No. 2, 152-63 (Dec., 1960).

In this general review, the problem of the evolution of a gravitating gas is first considered, with special reference to the slow fall-off of gravitational interaction energy with distance, and the consequent non-existence of a state of maximum probability. The concept of a gravitating gas can be applied to some problems of stellar clusters, but is inapplicable to the case of galactic evolution on account of the changes in the physical states, numbers and masses of the stars during the life-time of a galaxy. Attention is given to the possible active role of the nucleus in the formation of spiral arms, and also in the formation of globular clusters by an ejection process. R.A.Newing

Radioastronomy

8012 COSMIC RADIO WAVES AND THEIR INTERPRETATION. J.L.Pawsey and E.R.Hill.
Rep. Progr. Phys. (GB), Vol. 24, 69-113 (1961).

An attempt is made to present the main contributions of radio astronomy to our understanding of our own and external galaxies. Cosmic radio waves originate in interstellar gas by three distinct mechanisms: line emission (from hydrogen), thermal emission by free–free electron transitions, and a non-thermal process believed to be synchrotron emission. Each mechanism is discussed briefly. Observations, particularly of the line emission, have provided a great extension of knowledge of the distribution and motion of interstellar gas in galaxies. This includes data on rotation leading to estimates of mass distribution, on spiral structure, on the shape of the galactic disk, and on the relative proportions of gas and stars in different parts of our galaxy and in different galaxies. The synchrotron emission hypothesis implies the existence, in places where non-thermal cosmic radio waves originate, of interstellar magnetic fields and high energy electrons. Two cases of special interest are the remnants of supernovae, which are strong radio sources and may be the primary sources of cosmic rays, and galactic coronas, vast emitting regions which have been found to extend far beyond the stars in our own and some external galaxies. The discovery of radio galaxies has provided a fresh approach to cosmology. They appear to be observable far beyond current optical limits and, although no definite cosmological information has yet been established from radio evidence, it is probable that significant results may be obtained in the not distant future.

8013 SOME CHARACTERISTICS OF THE OHIO STATE UNIVERSITY 360-FOOT RADIO TELESCOPE.
J.D.Kraus, R.T.Nash and H.C.Ko.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 4-8 (Jan., 1961).

Design considerations and performance characteristics are discussed. The telescope is well suited for precision position and intensity measurements at frequencies from 30 to 2000 Mc/s. The beam-widths expected at 2 Gc/s are about 11 × 30 min of arc. Factors involved in determining the aerial temperature are considered, and an estimate is made of the expected temperature.

8014 THE UNIVERSITY OF ILLINOIS RADIO TELESCOPE. G.W.Swenson, Jr and Y.T.Lo.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 9-16 (Jan., 1961).

The telescope is a reflector in the shape of a parabolic cylinder whose aperture is 400 × 600 ft. A 425 ft long phase-adjustable array of receiving aerials lies along the focal line and produces a pencil beam $\frac{1}{3}^{0}$ in width, steerable in the meridian plane up to 30^{0} in either direction from the zenith. The array was designed by means of a novel procedure using both variable spacing and variable excitation to produce a prescribed beam width. The reflector is built of earth, utilizing a natural ravine. The purpose of the instrument is to compile a catalogue of faint extra-galactic radio sources.

8015 THE DESIGN AND CAPABILITIES OF AN IONOSPHERIC RADAR PROBE.
W.E.Gordon and L M.LaLonde.
IRE Trans Antennas and propagation (USA), Vol. AP-9, No. 1, 17-23 (Jan., 1961).

The radar will have the following general specifications: (1) Aerial reflector, 1000 ft diameter spherical bowl, illuminated by a 430 Mc/s dual-polarized feed. (2) Transmitter of 2.5 MW peak, 150 kW average power, or 100 kW c.w.power. (3) Dual-channel receiver, capable of measuring total power, polarization and received spectrum. The radar will initially be used to measure the variation of electron density with height, the fluctuations of electron density at fixed heights and electron temperatures and magnetic field strengths at various heights. Ionospheric drifts may also be measured. The radar will also be able to obtain echoes from planets, information of the moon's surface and possibly echoes from the sun. Hydromagnetic shocks may also be detected and a study of cislunar ionization can be made. The passive system with large aerial may be used as an instrument in radio astronomy to observe radio emission from planets and from true stars, and to make a survey of radio sources. With additional facilities, many radio astronomy measurements can be made taking advantage of the large aerial aperture and resulting high resolving power.

8016 THE STANFORD MICROWAVE SPECTROHELIOGRAPH ANTENNA, A MICROSTERADIAN PENCIL BEAM INTERFEROMETER. R.N.Bracewell and G.Swarup.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 22-3 (Jan., 1961).

A pencil beam interferometer has been constructed with multiple beams of 3.1 min of arc width to half power (0.8 microsteradian). It is composed to two equatorially-mounted, 16 element, Christiansen arrays of 3 m paraboloids, each 375 ft long (1255 wavelengths at 9.1 cm). The half power beam-width of the fan beam of a single array is 2.3 min of arc. To form the pencil beam, the two arrays are switched together as in a Mills cross. Frequency range is from 2700 to 3350 Mc/s. Phase adjustment and monitoring are handled by a technique of modulated, weakly reflecting gas-discharges maintained at the focus of the paraboloids. Television-type scanning yields maps of the sun (spectroheliograms) revealing fine details of the microwave source regions in the chromosphere and corona. All the transient bursts and a large fraction of the steady solar emission at 9.1 cm prove to originate in a small number of highly compact

centres, whose brightness temperatures may exceed 5×10^5 °K. The sensitivity of the instrument also allows the thermal emission from the moon (250° K) and a number of galactic and extragalactic sources to be studied with high angular resolution. Illumination of the moon by terrestrial radar can be detected. The pencil beam interferometer furnishes the finest beams currently available from pencil beam aerials of any type. Examination of the fundaments of extracting high resolution details of a source from its radiation field indicates the fitness of pencil beam interferometers, incorporating steerable multi-element arrays, for future development to higher resolving power. Adequate technique of phase preservation over wide spacings is available.

8017 TWO-ELEMENT INTERFEROMETER FOR ACCURATE POSITION DETERMINATIONS AT 960 Mc. R.B.Read.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 31-5 (Jan., 1961).

A 960 Mc/s two-element interferometer using the twin 90 ft steerable paraboloids of the California Institute of Technology Radio Observatory is described. The response of the associated receiving equipment as it applies to interferometric position measurements is analysed in some detail, and an advantage of not rejecting the image response of the receiver is mentioned. Finally, a brief account is given of the various ways the interferometer may be used to measure right ascensions and declinations with both an east-west and a north-south baseline.

8018 RECENT DEVELOPMENTS AND OBSERVATIONS WITH A RUBY MASER RADIOMETER.
M.E.Bair, J.J.Cook, L.G.Cross and C.B.Arnold.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 43-9 (Jan., 1961).

Recent developments in equipment design are detailed. Observations of radio sources are discussed, and response curves with and without the maser preamplifier are given. The detection of 3.45 cm radiation from the planet Saturn is reported, and the equivalent black-body disk temperature calculated. The future of the maser amplifier in radio astronomy is considered.

8019 INTERFEROMETRY AND THE SPECTRAL SENSITIVITY ISLAND DIAGRAM. R.N.Bracewell.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 59-67 (Jan., 1961).

Basic principles of radio interferometry are expounded and a special diagram is established which helps with problems on interferometers, especially those with phase switching or other complications. The information on a record, or interferogram, made by scanning a compact source or target with an interferometer comprising an aerial with two well-spaced parts, is all in one complex number, the complex visibility of the interference fringes. Under appropriate conditions, the complex visibility observed is equal to the complex coherence of the field produced by the source between the points occupied by the two elements of the interferometer. (If the elements are not infinitesimal in extent, the complex visibility is equal, instead, to a weighted mean of the values of complex coherence between the pairs of points embraced by the elements). Furthermore, this quantity gives the strength of one spatial Fourier component of the source distribution in amplitude and phase. Measurements at a finite number of spacings yield the principal solution; if the source is finite in extent, only certain discrete spacings need be used. The spectral sensitivity of aerials depends on the complex autocorrelation function of the aerial aperture distribution. For interferometers, the spectral sensitivity is confined to islands in the spatial frequency plane whose shorelines may be delineated by a simple graphical procedure. The spectral sensitivity island diagram offers an alternative approach to interferometer problems. In an application of the diagram, it is explained how the resolving power of a Mills cross is not impaired by deleting half of one arm.

8020 STEPPED CYLINDRICAL ANTENNAS FOR RADIO ASTRONOMY.
L.Ronchi, V.Russo and G.Toraldo di Francia.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 68-74 (Jan., 1961).

A stepped cylindrical mirror is described which satisfied the folowing requirements: (1) it is free from spherical aberration for a point source at infinity on the axis, (2) both off-axis spherical aberration and coma vanish for fixed values of the field angle, and of the aperture. The analysis was carried out, in the approximation of parageometrical optics, by considering a diffraction grating of the generalized type, equivalent to the stepped mirror. It was found that: (1) the equivalent diffraction grating has a quasi-parabolic cross-section, (2) the off-axis spherical aberration turns out to be negligible over the whole aperture for fields angles up to at least 20° (3) the residual coma is well corrected

8021 VOLTAGE-TUNED SWEPT-FREQUENCY RECEIVER. J.J.Riihimaa.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 289-91 (March, 1961).

A voltage-tuned low frequency solar spectrum analyser was developed. This analyser tunes over the range 15 to 30 Mc/s at rates up to 10/sec. A description is given of the voltage-controlled tuner device which employs silicon capacitors.

8022 AN INTERFEROMETER FOR THE MEASUREMENT OF RADIO SOURCE SIZES.
B.R.Goddard, A.Watkinson and B.Y.Mills.
Austral. J. Phys., Vol. 13, No. 4, 665-75 (Dec., 1960).

Modifications have been made to the 85.5 Mc/s cross-type radio telescope at Sydney to permit the measurement of radio source sizes in the range of 10" to 1' arc. The basic modification involves the addition of another aerial at a distant site connected by radio link. A new form of automatic gain control ensures very good stability for the system. The modified instrument is described in general terms and calibration techniques are discussed.

8023 MICROWAVE POLARIZATION AND CORONAL MAGNETIC FIELDS. M.H.Cohen.
Astrophys. J. (USA), Vol. 133, No. 3, 978-82 (May, 1961).

It is suggested that the reversal of the rotation of the plane of polarization commonly observed in solar microwave bursts is a propagation phenomenon, caused by a mode of magnetoionic coupling in a quasi-transverse region. The parameter which can then be estimated most reliably from the observations is the strength of the magnetic field in the quasi-transverse region. The model chosen for the magnetic field is the field of a force-free dipole buried beneath the photosphere. It is estimated that the field strength at heights of the order of 10^5 km above the active region is commonly between 2 and 6 gauss.

8024 THE RADIO BRIGHTNESS OF THE QUIET SUN AT 21 CM WAVELENGTH NEAR SUNSPOT MAXIMUM.
N.R.Labrum.
Austral.J. Phys., Vol. 13, No. 4, 700-11 (Dec., 1960).

An investigation has been made of the radio emission from the quiet Sun at 21.2 cm wavelength in 1958 (near sunspot maximum). Two different methods have been used, both involving observations with very high angular resolution, to distinguish between the quiet-Sun component and the radiation from localized active regions. In one method, the Sun was scanned with a narrow pencil-beam; in the other, a fan-shaped aerial beam was used to give one-dimensional strip scans. In both cases it was necessary, when analysing the data, to take into account the residual effects of the very intense radiation from the localized sources. The two independent measurements gave results which agree within the limits of error. The apparent disk temperature was found to be approximately 140 000° K, or twice the value for the same wavelength at sunspot minimum. The fan-beam observations also provide some evidence on the distribution of quiet-Sun brightness with respect to heliographic latitude. There is limb darkening at the poles, and the distribution does not appear to have changed in shape between sunspot minimum (1953) and the time of the present series of observations.

8025 CENTIMETER-WAVE SOLAR BURSTS AND ASSOCIATED EFFECTS. M.R.Kundu and F.T.Haddock.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 82-8 (Jan., 1961).

Most knowledge of solar bursts in the metre-wave region has been derived from dynamic spectral observations. Systematic spectral observations have led to the classification of metre-wave bursts into distinct spectral types. No such classification exists for cm-wave bursts because spectral observations are only just beginning. However, recent interferometric measurements have enabled the cm-wave bursts to be classified into a number of distinct types. The properties of such different types of cm-wave bursts are discussed in relation to their associated effects. Dynamic spectral observations of cm-wave bursts obtained at the University of Michigan show that cm-wave burst emission is a broad-band continuum, similar in nature to metre-wave type-IV and type-V emission.

8026 THE SPECTRUM OF RADIOFREQUENCY SOLAR BURSTS IN THE CENTIMETRE RANGE.

O.Hachenberg and G.Wallis.

Z. Astrophys. (Germany), Vol. 52, No. 1, 42-72 (1961). In German.

The continuous spectrum of bursts was observed at 6 different frequencies in the range from 500 to 25 000 Mc/s, and the intensity distribution in the spectrum was determined. The continuum sets in between about 500 and 1000 Mc/s. First, the intensity rises with $\nu^n (n \cong 2)$. The range within which the intensity rises monotonically with frequency is followed by another one where the intensity is almost independent of frequency. The transition to the range of constant intensity is monotonic in some spectra; in others the transition occurs through a broad maximum. In addition to this, part of the spectra also display maxima in the range of rising intensity, and occasionally also maxima superposed on the region of constant energy. The maxima are broad; their intensity may rise to five times the amount of the adjoining continuum of equal energy. An attempt was made at a theoretical interpretation of the spectrum. The spectrum resembles that of a plasma which is optically thick at low frequencies, optically thin at high frequencies. The superposed maxima may probably be attributed to synchrotron radiation of classical electrons. The necessary magnetic fields would be between 100 and 1000 G. If the electron temperature is determined for the optically thick part of the spectrum, then one obtains for the decaying part of the bursts (postburst increase) values around 10^7 degrees, provided that values compatible with observations are taken for the emitting area. In some cases the temperatures obtained for burst maxima are too high ($>5 \times 10^7$ degrees). In the optically thin part of the spectrum, the emitted radiation depends not only on temperature and the emitting area, but also on optical thickness. An upper boundary of the electron density is given by the conditions for the propagation of electromagnetic waves. Even the temperatures determined by using the upper limit of the electron densities differ from those obtained for the optically thick part of the spectrum. An interpretation of burst maxima as synchrotron radiation of relativistic electrons, as suggested by others, meets with difficulties in the interpretation of the X-ray component of the bursts.

8027 THE CHARACTERISTICS OF PERSISTENT SPORADIC METEOR ECHOES. J.W.Smith.

Austral. J. Phys., Vol. 14, No. 1, 89-101 (March, 1961).

Examines the frequency distribution of the durations of nearly 8000 persistent radio echoes from sporadic meteors recorded at Adelaide during 1957. The maximum line densities in the trails formed by these meteors exceed 10^{13} electrons/cm, corresponding to visual magnitudes $< +3$. As the echo duration increases, the numbers of echoes are found to fall progressively further below the numbers expected from a power-law distribution. No significant seasonal or diurnal variation in the mass distribution of the meteors examined is apparent. Echo trace irregularities, which have been classified into five distinct types, are present in 43% of the persistent echoes recorded. Four of these types of irregularity are attributed to distortion of the trail due to atmospheric turbulence, whilst the fifth (leader echo) type is associated with the process of trail formation. The characteristics and diurnal variation in incidence of each type are examined in detail.

8028 THE DISTRIBUTION OF METEOR MASSES FOR SPORADIC METEORS AND THREE SHOWERS.

A.A.Weiss.

Austral. J Phys., Vol. 14, No. 1, 102-19 (March, 1961).

Distributions of maximum line densities (α_{max} electrons/cm) in meteor trails, and hence distributions of meteor masses, are derived from radio-echo data for sporadic and shower meteors. Distributions are obtained in the range $10^{11} < \alpha_{max} < 10^{12}$ from comparisons of echo rates, and for $\alpha_{max} > 10^{13}$ from durations of persistent echoes. For $\alpha_{max} > 10^{11}$ the mass distributions cannot be represented by a simple inverse power law with constant exponent s. For sporadic meteors s increases from 2.0 for $10^{11} < \alpha_{max} < 1$ to 2.5 for $\alpha_{max} > 10^{13}$. For the η-Aquarid, δ-Aquarid, and Geminid showers, $s < 2.0$ for $\alpha_{max} < 5 \times 10^{13}$, and $s \geq 2.0$ for $\alpha_{max} \geq 5 \times 10$. The δ-Aquarids exhibit a concentration of bright meteors to the centre of the stream. It is suggested that the extent of fragmentation of shower meteors (relative to sporadic meteors) can be estimated from comparisons of the values of s found for the same shower by the echo rate method described here and by the height distribution method developed at Jodrell Bank.

8029 A CATALOGUE OF RADIO SOURCES BETWEEN DECLINATIONS -20° AND -50°.

B.Y.Mills, O.B.Slee and E.R.Hill.

Austral. J. Phys., Vol. 13, No. 4, 676-99 (Dec., 1960).

A catalogue was prepared using the Sydney cross-type radio telescope at a wavelength of 3.5 m; a total of 892 sources is listed. This supplements an earlier catalogue in the declination zone $+10^\circ$ to -20° (Abstr. 4869 of 1960). In addition to the positions and intensities of the sources, angular sizes of 50 of the strongest are given; several are found to have a size less than 15" arc. As before, identifications with bright optical objects have been sought, and a number of galaxies of apparently abnormal radio emission listed. Statistical analyses of the distribution of the radio sources give results very similar to those obtained using the earlier catalogue. Within the uncertainty in the data, the distribution appears uniform in depth and there is a significantly greater number of sources of large apparent size than expected from chance blending effects.

A STUDY OF NEUTRAL HYDROGEN IN A REGION IN CYGNUS. See Abstr. 7977

Space Research

IONIZING RADIATION DETECTED BY PIONEER II. See Abstr. 7295

8030 A TRANSATLANTIC COMMUNICATION EXPERIMENT VIA ECHO I SATELLITE.

H.Carru, R.Gendrin and M.Reyssat.

Nature (GB), Vol. 189, 268-71 (Jan. 28, 1961).

Details are given of experimental results obtained in France on reception of a frequency of 960 Mc/s from New Jersey via the balloon satellite Echo I. The reflectivity and sphericity of the balloon were good, and the received signals were free from rapid fading. For communication purposes, however, the band-width capabilities are severely limited, even with elaborate equipment.

G.M.Bro

ROCKET ELECTRON DENSITY MEASUREMENTS AT FORT CHURCHILL, CANADA. See Abstr. 7936

PHYSICS

GENERAL

8031 INTERNATIONAL DICTIONARY OF PHYSICS AND ELECTRONICS.
2nd ed. Princeton, N.J., Toronto, London, New York: D.Van Nostrand (1961) 1355 pp.

A new edition of this well-established reference book. It has been extensively revised to include new terms and new meanings of old ones which have resulted from the rapid progress in physics since the publication of the first edition. The cross-reference system has been improved and errors and omissions corrected. A new feature which is a major improvement is the inclusion of a group of multilingual indexes in French, German, Russian and Spanish. Physicists unfamiliar with the book in either edition will find it invaluable for general reference, including subject-areas bordering on physics.

8032 HANDBOOK OF CHEMISTRY AND PHYSICS.
Edited by C.D.Hodgman, R.C.Weast and S.M.Selby.
42nd ed. Cleveland, Ohio: Chemical Rubber Publishing Co. (1960) xxv + 3481 pp.

A new edition of this standard work. One of the most compact reference books in print today, it is normally regarded as indispensable in laboratories and reference libraries. In continuance of the normal policy of the editors, many of the tables have been revised and a substantial number of new tables are included.

8033 JERROLD REINACH ZACHARIAS: OERSTED MEDALIST FOR 1960. F.W.Sears.
Amer. J. Phys., Vol. 29, No. 6, 345-6 (June, 1961).

Remarks made by the Chairman of the Committee on Awards for 1960 during the presentation ceremony of the Oersted Model to Jerrold Reinach Zacharias in recogition of his notable contributions to the teaching of physics.

8034 TEAM APPROACH TO EDUCATION.
J.R.Zacharias.
Amer. J. Phys., Vol. 29, No. 6, 247-9 (June, 1961).

The Response of the Oersted Medallist to the American Association of Physics Teachers, February 2, 1961.

8035 THE NEW UNIT OF ATOMIC MASS.
H.E.Duckworth.
Canad. J. Phys., Vol. 39, No. 4, 639 (April, 1961).

At the 10th General Assembly of the International Union of Pure and Applied Physics, held in Ottawa in September, 1960, the following resolution was adopted unanimously: "The 10th General Assembly of the I.U.P.A.P. recommends the adoption of the exact number 12 as the relative nuclidic mass of the carbon isotope of mass number 12. This action will effect a unification of the physical scale of relative nuclidic masses and the chemical scale of atomic weight." The new unit of mass is to be designated by the symbol u: thus, $C^{12} = 12$ u.

8036 THE NEW STANDARD FOR THE METRE.
L.E.Howlett.
Canad. J. Phys., Vol. 39, No. 4, 639-41 (April, 1961).

On 14 October, 1960, at the 11th International Conference on Weights and Measures, the physical prototype for the International Metre, a platinum iridium bar bearing two fine lines, which since 1889 has preserved the world's basic unit of length, was relegated to the position of an honoured scientific museum piece by the adoption of the following resolution to base henceforth the International Metre on a wavelength of light: "The metre is the length equal to 1 650 763.73 wavelengths in vacuum of the radiation corresponding to the transition between the levels $2p_{10}$ and $5d_5$ of the atom of krypton 86".

HISTORY OF THE PHOTOMETRIC QUANTITIES. See Abstr. 8212

8037 IDENTITIES SATISFIED BY A LAGRANGIAN.
M.Godart.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 46, No. 10, 855-61 (1960). In French.

The Lagrangian, which is a scalar density, is a general function of the coordinates, of any set of tensors and their first and second partial derivatives, and of the components of an affine connection and their first partial derivatives (cf. J. Geheniau, Bull. Acad. Roy. Belgique Cl. Sci. Vol. 28, 118 (1942) and Abstr. 2177 of 1953).

F.A.E.Pirani

GRAVITATION . RELATIVITY

ANALYSIS OF THE PHYSICAL CONSEQUENCES OF A GENERAL EXCESS OF CHARGE AS AN EXPLANATION OF GRAVITATION. See Abstr. 7974

8038 MATTER, ANTI-MATTER, AND GRAVITATION.
W.F.G.Swann.
Astrophys. J. (USA), Vol. 133, No. 3, 733-7 (May, 1961).

The paper forms an extension, to include matter and anti-matter, of Lorentz' suggestion that gravitation may be understood by supposing that the attraction between unlike elementary charges exceeds the repulsion between like charges by a small amount. The extension considered is one in which the forces between charged particles are of normal form multiplied by a factor $(1 + \epsilon)$ for cases where one and only one of the particles is a heavy particle (proton or anti-proton), while the normal form applies to all other cases. The hypothesis leads to the conclusion that like pieces of matter attract and unlike pieces of matter repel, where like and unlike are to be understood in the sense of ordinary matter and anti-matter. The bearing of the general theory of relativity upon the question is also discussed.

8039 INTERNAL STATE OF A GRAVITATING GAS.
G.E.Tauber and J.W.Weinberg.
Phys. Rev. (USA), Vol. 122, No. 4, 1342-65 (May 15, 1961).

The significance of a theory of gravitational equilibrium of concentrated masses is discussed in connection with possible general relativistic effects in white dwarf stars. The covariant form of phase space and Liouville's theorem is developed, using the canonical equations for a particle under gravitational and electromagnetic forces. The dynamical isotropy of the ideal fluid is formulated, and the associated equations of state and allowed streaming patterns are found. A covariant kinetic theory yields general relativistic forms for the Maxwell and Fermi distributions in the case of thermal equilibrium, and limits their streaming to rigid motion. Rotating fluids are studied in comoving coordinates, and the problem of determining their gravitational equilibrium is reduced, in most cases of physical interest, to a simple standard form with constant density and vorticity.

8040 UPPER LIMIT FOR INTERSTELLAR MILLICYCLE GRAVITATIONAL RADIATION.
R.L.Forward, D.Zipoy, J.Weber, S.Smith and H.Benioff.
Nature (GB), Vol. 189, 473 (Feb. 11, 1961).

The Riemann tensor power spectrum was measured by observation of the earth's vibrations. The limit in the vicinity of 1c/hr, 10^{-75} cm^{-4} $(rad/sec)^{-1}$, was derived from data obtained from a Benioff strain seismograph at Isabella, California, during a quiet period when the earth's natural vibrational modes did not contribute to the strains (cf. Abstr. 6655 of 1960). F.A.E.Pirani

8041 ON THE ENERGY-MOMENTUM TENSOR OF THE GRAVITATIONAL FIELD. F.R.Tangherlini.
Nuovo Cimento (Italy), Vol. 20, No. 1, 1-19 (April 1, 1961).

In a previous note (Abstr. 62 of 1961) it was suggested that $\kappa^{-1} \Lambda g_{\mu\nu}$, with $\Lambda > 0$ fulfills the basic requirements of a generally covariant energy-momentum tensor for the gravitational field. Some further justification is given for this hypothesis by (a) studying the character of the field equations in the absence of the cosmological

term; (b) a re-interpretation of the line elements based on Mach's principle; (c) calculating the gravitational proper energy due for de Sitter static universe with and without a Schwarzschild field present and showing that the difference is proportional to the Schwarzschild mass. Finally an attempt is made to define a true tensor for the angular momentum density. It is shown that in this way one is lead to a definition of "physical coordinates". These coordinates are determined in such a way that in the weak-field limit they approach the usual Lorentz coordinates. However it is not possible to arrive at these coordinates by imposing coordinate conditions, since they form the components of a vector. To the extent that the angular momentum of the gravitational field is covariantly conserved, the coordinates may be obtained as the gradient of a world scalar which satisfies an inhomogeneous d'Alembertian equation.

8042 THE PLANE-FRONTED GRAVITATIONAL WAVES. W.Kundt.
Z. Phys. (Germany), Vol. 163, No. 1, 77-86 (1961).

A contribution to the theory of pure radiation in general relativity. It gives a survey of the radiation fields which possess a twist-free and non-expanding null congruence, and characterizes their subclasses of different Petrov type by geometrical properties. The term "plane-fronted", intuitive in Maxwell's theory, is generalized to Einstein's theory.

SINGULARITIES OF THE COSMOLOGICAL SOLUTIONS OF GRAVITATIONAL EQUATIONS. See Abstr. 7976

8043 RELATIVISTIC HYDRODYNAMICS OF ROTATING FLUID MASSES MOVING WITH THE VELOCITY OF LIGHT. P.Hillion, T.Takabayasi and J.P.Vigier.
Acta phys. Polon. (Poland), Vol. 19, No. 2, 245-70 (1960).

A discussion is given of the motion of rotating fluid masses with velocities near to that of light. This provides a relativistic model of the hydrodynamical interpretation of the neutrino equation.

C.W.Kilmister

8044 LENGTH CONTRACTION PARADOX. W.Rindler.
Amer. J. Phys., Vol. 29, No. 6, 365-6 (June, 1961).

A certain man walks very fast — so fast that the relativistic length contraction makes him very thin. In the street he has to pass over a grid. A man standing at the grid fully expects the fast thin man to fall into the grid. Yet to the fast man the grid is much narrower even than to the stationary man, and he certainly does not expect to fall in. The paradox is discussed in terms of the relativity of rigidity.

BOSE STATISTICS IN RELATIVITY THEORY. See Abstr. 8077

8045 OPTICAL OBSERVATIONS IN GENERAL RELATIVITY. J.L.Synge.
RC Semin. Mat. Fis. Milano (Italy), Vol. 30, 33 pp. (1960).

Problems involved are essentially in the geometry of curved space-time. They involve null geodesics representing light signals and time-like world lines representing an observer or pieces of optical apparatus. For systematic approximate calculations, use is made of an invariant two-point world-function, which permits expansions in power series without loss of tensor form. The following topics are discussed: measurement of time and direction, frames of reference, bouncing photon, Doppler effect, Fermi transport and Fermi coordinates, generalized Michelson–Morley experiment, Sagnac effect.

8046 LOCALIZATION OF ENERGY IN GENERAL RELATIVITY. A.Uhlmann.
Acta. phys. Polon. (Poland), Vol. 19, No. 2, 133-8 (1960).
In German.

It is shown that Møller's affine tensor density, i.e. a tensor under the transformations

$$y^4 = x^4;\ y^k = A^k(x^1, x^2, x^3)\ (k = 1, 2, 3),$$

has the greatest possibility of being a localized energy; so that, since it is not, the hope of finding such a one is small.

C.W.Kilmister

8047 COORDINATE INVARIANCE AND ENERGY EXPRESSIONS IN GENERAL RELATIVITY. R.Arnowitt, S.Deser and C.W.Misner.
Phys. Rev. (USA), Vol. 122, No. 3, 997-1006 (May 1, 1961).

The invariance of various definitions proposed for the energy and momentum of the gravitational field is examined. The authors used the boundary conditions that $g_{\mu\nu}$ approaches the Lorentz metric as $1/r$, but allow $g_{\mu\nu,\,\alpha}$ to vanish as slowly as $1/r$. This permits "coordinate waves". It is found that none of the expressions giving the energy as a two-dimensional surface integral are invariant within this class of frames. In a frame containing coordinate waves they are ambiguous, since their value depends on the location of the surface at infinity (unlike the case where $g_{\mu\nu,\,\alpha}$ vanishes faster than $1/r$). If one introduces the prescription of space-time averaging of the integrals, one finds that the definitions of Landau–Lifshitz and Papapetrou–Gupta yield (equal) coordinate-invariant results. However, the definitions of Einstein, Moller, and Dirac become unambiguous, but not invariant. The averaged Landau–Lifshitz and Papapetrou–Gupta expressions are then shown to give the correct physical energy-momentum as determined by the canonical formulations Hamiltonian involving only the two degrees of freedom of the field. It is shown that this latter definition yields that inertial energy for a gravitational system which would be measured by a nongravitational apparatus interacting with it. The canonical formalism's definition also agrees with measurements of gravitational mass by Newtonian means at spacial infinity. It is further shown that the energy-momentum may be invariantly calculated from the asymptotic form of the metric field at a fixed time.

8048 INITIAL VALUE DATA FOR POISSON BRACKETS IN GENERAL RELATIVITY. J.G.Fletcher.
Ann. Phys. (USA), Vol. 12, No. 2, 283-94 (Feb., 1961).

As a preliminary step toward constructing the commutators of a quantized theory of general relativity, Poisson brackets for the classical theory are found on an initial space-like surface. These can be extended over all space-time by solving the equations of motion. The theoretical structure used to find the brackets is an extension of the formalism of Schwinger. The brackets obtained are determined only up to a gauge transformation.

8049 STATIC ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. B.K.Datta.
Ann. Phys. (USA), Vol. 12, No. 2, 295-9 (Feb., 1961).

The equations of Rainich's "already unified theory" are solved for two simple types of static metric: (1) where the space-time admits of a group of motion whose minimum invariant varieties are two-dimensional spacelike surfaces of constant negative curvature; (2) for a space exhibiting an abnormal spherical symmetry. In the first case the solution bears a striking formal similarity to the Reissner–Nordstrom solution for a point charge whereas the second case shows some interesting features.

8050 NEUTRINOS, GRAVITATION AND GEOMETRY. J.A.Wheeler.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p.67-196.

Expounds "geometrodynamics", which unites classical electromagnetism and Einstein's general relativity in purely geometrical terms. Describes some novel entities in this physics of curved empty space, and conjectures how quantization, elementary particles and in particular neutrinos may be added. Discusses some related nuclear and astrophysical questions. See Abstr. 1468-9 of 1958.

R.J.N.Phillip

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

8051 DERIVATION OF THE QUANTUM LAW FROM NON-QUANTUM PRINCIPLES. A. Landé.
Z. Phys. (Germany), Vol. 162, No. 4, 410-12 (1961). In German.

The general law of probability interference is only the first step to quantum mechanics; it does not yet contain wave-like periodic traits. The latter enter the theory only through additional dynamical rules for the connection between coordinates and momenta, typified by the wave function

$$\Psi(p, q) = \exp(2i\pi qp/h).$$

This quantum-dynamical rule is shown to be derivable from a non-quantal, non-periodic requirement of invariance of certain quantities with respect to displacement of the zero point in q- and p-space.

8052 TIME IN THE QUANTUM THEORY AND THE UNCERTAINTY RELATION FOR TIME AND ENERGY.
Y.Aharonov and D.Bohm.
Phys. Rev. (USA), Vol. 122, No. 5, 1649-58 (June 1, 1961).

Because time does not appear in Schrödinger's equation as an operator but only as a parameter, the time—energy uncertainty relation must be formulated in a special way. This problem has in fact been studied by many authors and a summary is given of their treatments. The main conclusion of these treatments is then criticized, viz., that in a measurement of energy carried out in a time interval, Δt, there must be a minimum uncertainty in the transfer of energy to the observed system, given by $\Delta(E' - E) \geq h/\Delta t$. It is shown that this conclusion is erroneous in two respects. First, it is not consistent with the general principles of the quantum theory, which require that all uncertainty relations be expressible in terms of the mathematical formalism, i.e., by means of operators, wave-functions, etc. Secondly, the examples of measurement processes that were used to derive the above uncertainty relation are not general enough. The authors then develop a systematic presentation of their own point of view, with regard to the role of time in the quantum theory, and give a concrete example of a measurement process not satisfying the above uncertainty relation.

PERIODIC QUANTUM SYSTEMS. See Abstr. 8371

8053 REPRESENTATIONS OF THE UNITARY GROUP AND WAVE FUNCTIONS. H.A.Venables.
Canad. J. Phys., Vol. 39, No. 4, 510-13 (April, 1961).

A number of wave functions besides the spherical harmonics are obtainable from the irreducible representations of the two-dimensional unitary group.

8054 APPLICABILITY OF APPROXIMATE QUANTUM-MECHANICAL WAVE FUNCTIONS HAVING DISCONTINUITIES IN THEIR FIRST DERIVATIVES.
J.O.Hirschfelder and G.V.Nazaroff.
J. chem. Phys. (USA), Vol. 34, No. 5, 1666-70 (May, 1961).

The method of convolutions is used to form smoothed functions from approximate wave-functions which are discontinuous or have discontinuous first derivatives. As a parameter ϵ in the smoothed function approaches the approximate wave-function. The expectation values for physical properties corresponding to the approximate wave-function are defined to be the limit as ϵ approaches zero of the expectation values corresponding to the smoothed function. It is found that if the approximate wave-function is discontinuous, the corresponding expectation value for the kinetic energy is infinite. Therefore, it seems unlikely that discontinuous approximate wave-functions can ever be useful. However, if the approximate wave-function is continuous but has a discontinuity in its first derivative, then, as a result of the discontinuity, there is a contribution $\delta\bar{T}_{12}$ to the expectation value of the kinetic energy. For a one-dimension problem

$$\delta\bar{T}_{12} = -(\hbar^2/2m)\psi^*(0)[\psi_2'(0) - \psi_1'(0)].$$

Here $\psi(0)$ is the value of the approximate wave-function at the point zero where the discontinuity in its first derivative occurs, and $\psi_1'(0)$ and $\psi_2'(0)$ are the first derivatives of ψ taken from the left and from the right, respectively, at this point. Similarly, for an N-dimensional problem having a surface $S_{12} = 0$ over which the first derivatives of the approximate wave-function are discontinuous,

$$\delta\bar{T}_{12} = \int_{\text{surface}} \psi^*[(\partial/\partial n)(\psi_2 - \psi_1)]dS_{12}.$$

Here the $\partial/\partial n$ is the normal derivative with the normal pointed from region 1 towards region 2.

THE QUANTUM MECHANICAL EFFECTS OF MAGNETIC FIELDS CONFINED TO INACCESSIBLE REGIONS. See Abstr. 8373

8055 SOLUTION OF THE SCHROEDINGER EQUATION IN A CONSTANT MAGNETIC FIELD AND DIAMAGNETISM.
N.Minnaja.
Physica (Netherlands), Vol. 26, No. 10, 827-33 (Oct., 1960).

The Schroedinger equation for charged particles without spin in a cylindrical box and subject to a constant magnetic field is solved exactly. The energy eigenvalues are determined, and the results are compared with those of Landau for the diamagnetism of a gas of charged particles.

8056 ANALYTICITY IN THE COUPLING CONSTANT AND BOUND STATES IN POTENTIAL THEORY.
B.Bosco and J.Sucher.
Nuovo Cimento (Italy), Vol. 19, No. 4, 1183-8 (March 16, 1961).

A method for determining the wave-function in potential scattering from the S-matrix, using unitarity and analyticity, is extended to the case where bound states are present by using analytic continuation in the coupling constant. Anumerical example is given, illustrating the passage of a pole from the second Riemann sheet of the energy to the first sheet.

8057 ON THE CALCULATION OF THE t-MATRIX FOR POTENTIALS WITH A HARD CORE.
J.M.J.Van Leeuwen and A.S.Reiner.
Physica (Netherlands), Vol. 27, No. 1, 99-110(Jan., 1961).

An explicit calculation of the t-matrix for general complex argument is described for potentials consisting of a chain of rectangular wells. Details are given for the hard sphere interaction and the Herzfeld potential. The method is compared with the resolvent method, pointing out the care needed when a hard core is present in the interaction.

STATISTICAL MECHANICS TRANSFER PROCESSES

8058 ASSOCIATION PROBLEM IN STATISTICAL MECHANICS — CRITIQUE OF THE TREATMENT OF H.S.GREEN AND R.LEIPNIK. M.E.Fisher and H.N.V.Temperley.
Rev. mod. Phys. (USA), Vol. 32, No. 4, 1029-31 (Oct., 1960).

Points out a mathematical error in the paper by Green and Leipnik (Abstr. 8559 of 1960). Their recurrence relation is correct, but a fallacious assumption is used to solve it. It leads to the correct solutions of certain one-dimensional problems, but an attempt to apply it to the two-dimensional square lattice (the problem being the distribution of non-overlapping "dimers" on such a lattice), leads to an incorrect result. H.N.V.Temperley

8059 ON GREEN AND LEIPNIK'S METHOD FOR SOLUTION OF THE ASSOCIATION PROBLEM.
S.Katsura and S.Inawashiro.
Rev. mod. Phys. (USA), Vol. 32, No. 4, 1031-2 (Oct., 1960).

See preceding abstract. These authors point out the same fundamental error and show that it leads to incorrect solutions in the two- and three-dimensional lattices. H.N.V.Temperley

8060 STATISTICAL MECHANICAL DERIVATION OF THE GENERALIZED BOLTZMANN EQUATION FOR A FLUID CONSISTING OF RIGID SPHERICAL MOLECULES.
J.V.Sengers and E.G.D.Cohen.
Physica (Netherlands), Vol. 27, No. 2, 230-44 (Feb., 1961).

An analysis is made as to whether the modified Boltzmann equation originally proposed by Enskog (1922) with intuitive arguments can be justified by a statistical mechanical derivation. In a

preceding paper (1960) the theory of Bogolubov and the theory of Kirkwood as to the derivation of a generalized Boltzmann equation for a dilute gas are compared and it is proved that corrections to the ordinary Boltzmann equation due to the first order terms of an expansion in terms of a uniformity parameter μ are equal. In the present paper both theories are applied to a dense system of rigid spherical molecules. It is shown that both theories give again a similar equation for the first distribution function, leading under a number of assumptions to the Enskog equation. It has been stated that the theory of Kirkwood would lead to an equation for the first distribution function essentially different from the Enskog equation and suggestions are raised elsewhere that this disparity might be due to the integration procedure applied to the Liouville equation, which would not be legitimate for a discontinuous rigid sphere potential. On the contrary to this the present derivation shows that also in the theory of Kirkwood, the Enskog equation can be obtained from the general (N – 1) times integrated Liouville equation.

8061 THE BOLTZMANN EQUATION FOR A BOUNDED MEDIUM. I. GENERAL THEORY. S.Simons.
Phil. Trans A (GB), Vol. 253, 137-84 (Oct. 27, 1960).

A general theoretical treatment is given of the linearized Boltzmann equation for flow in a bounded medium under conditions when the collision mean free path is of the order of the dimensions of the cross-section of the specimen. The approach given may be used for any type of particle; here gas molecules, electrons and phonons are considered. Section1 is concerned with elucidating various results for a specimen of general cross-section. The Boltzmann equation for any type of internal scattering mechanism is obtained, and the boundary conditions relating to the scatter of particles by the specimen surfaces are dealt with. Employing a very general form for these, a uniqueness theorem is proved for the solution of the problem. Certain general symmetry properties of the solution are discussed, and transport considerations are dealt with. Finally, a frequently used approximate treatment of boundary scatter is placed on a firmer mathematical foundation. Section 2 is concerned with a detailed evaluation of the solution of the Boltzmann equation and boundary conditions for the flow between parallel plates. Previous treatments of this problem have assumed a "relaxation-time" approximation for representing the effect of interparticle collisions in the medium, together with certain simplified boundary conditions. These two assumptions effectively remove the "coupling" which should exist between the equations relating to the different particle modes, and thus greatly simplify the solution of the problem. The complete Boltzmann equation is retained which is equivalent to a set of coupled first-order differential equations, and its general solution found to contain various undetermined constants, which are then calculated via the general boundary conditions. This general solution is obtained as the sum of a complementary function and a particular integral. The former involves the eigenfunctions and eigenvalues of a modified collision operator, while the form taken by the latter depends on whether or not wave number (equivalent to momentum) is conserved in interparticle collisions. If wave number is not conserved, the particular integral is the solution of the Boltzmann equation for an infinite medium. The complementary function is then a combination of terms, varying exponentially with respect to distance, which correspond to a decrease in the neighbourhood of the boundary; these are qualitatively of the same form as when a relaxation time is employed. On the other hand, if wave number is conserved, the equation for an infinite medium possesses no solution and it is then found that the particular integral corresponds to a quadratic variation with respect to distance between the boundary surfaces. When the distance between these surfaces is sufficiently greater than the collision mean free path this quadratic variation is shown to differ from the usual "viscous flow" theory by terms which are of importance only in the neighbourhood of the boundary; these, together with the complementary function, give the boundary corrections to the usual theory. The combination of quadratic particular integral and exponential complementary function is shown to give rise to the possibility of a "Knudsen minimum", which has so far been observed both in gases and in phonon flow in liquid helium. throughout the paper a general anisotropic medium is assumed and thus the theory of viscous flow is incidentally generalized, which was previously considered only for an isotropic medium in the case of gas molecules. Finally, a consideration is given of the situation when a small proportion of collisions not conserving wave number occurs together with a very large proportion of collisions that do conserve it; this is relevant to the effect of impurities and other momentum-destroying mechanisms at low temperatures. The result for general separation of the boundaries is obtained, and it is found that if this is large enough, the total particle flow is similar to th occuring in the absence of wave number conserving processes. ever, the flow variation on leaving the boundary is now accurately characterized by a relaxation length which is the geometrical mea of the relaxation lengths for the two types of collision process act separately.

8062 ON THE CONNECTION BETWEEN VARIOUS DERIVATIONS OF THE BOLTZMANN EQUATION. E.G.D.Cohen.
Physica (Netherlands), Vol. 27, No. 2, 163-84 (Feb., 1961).

It is shown that the time-smoothed second distribution functi used by Kirkwood (1947) in his derivation of the Boltzmann equati is identical with that obtained by Bogolubov (1946) by a systemati expansion in the two parameters 1/v (density) and μ (uniformity) and keeping terms of $O(1/v)$ and of $O(\mu)$. This leads not only in b cases to the Boltzmann equation but also to identical correction terms of $O(\mu)$ on this equation. A similar analysis is carried ou as regards to the derivations of Yvon (1935), Born and Green (194 Hollinger and Curtiss (1960), Schönberg (1953) and Frisch (1954). Contrary to the methods of Bogolubov and Kirkwood, these deriva tions do not, however, introduce explicitly or correctly coarse-grained distribution functions.

8063 ON A GENERALIZATION OF SMOLUCHOWSKI'S DIFFUSION EQUATION. P.C.Hemmer.
Physica (Netherlands), Vol. 27, No. 1, 79-82 (Jan., 1961).

The Brinkman–Sack equation (Abstr. 2701 of 1956; 9018 of 1957) is solved for a free Brownian particle, and the solution is compared with Ornstein and Uhlenbeck's exact solution (1930). T distribution obtained has the correct variance, but does not appro mate the exact distribution in the initial stage.

8064 THERMODYNAMIC THEORY OF THE PAIR CORRELATION FUNCTION. E.W.Hart.
J. chem. Phys. (USA), Vol. 34, No. 5, 1471-5 (May, 1961).

The thermodynamic description of inhomogeneous systems is adapted to a determination of the pair correlation function. The method is most effective for describing the correlation behaviour near a critical point. The critical point behaviour is investigated for a simple model fluid of the van der Waal's type. A novel optical scattering phenomenon is predicted for the interface between two equilibrium phases for temperatures below but very near to the critical temperature. The effect of inclusions on criti point phenomena is noted.

8065 STATISTICAL MECHANICS OF ISOTOPE EFFECTS ON THE THERMODYNAMIC PROPERTIES OF CONDENSED SYSTEMS. J.Bigeleisen.
J. chem. Phys. (USA), Vol. 34, No. 5, 1485-93 (May, 1961).

Evidence for the role of molecular structure on the differenc in the thermodynamic properties of isotopic molecules in the liquid and solid states is summarized. The properties considere are vapour pressure, heats of vaporization, molal volume, and transition temperatures. It is shown that the molecular structure must be taken into consideration even for small quantum effects. In the approximation of the first quantum correction the differenc in thermodynamic properties of isotopic molecules in the condens state depends upon the atomic masses and an energy parameter associated with each atom in the molecule. The results are extended to higher-order quantum corrections for a harmonic potential. The rules of the mean are obtained directly. Various frequency distributions for the lattice modes are considered. Fo the case where the internal frequencies in the condensed phase are similar to the free molecule, the ordered quantum correction can be used for $T > (h\nu_{max}/12(2)^{1/2}k)$ mol; $T > (h\nu_{lattice}/2\pi k)$. T role of the gas imperfection and the molal volume of the condens phase is discussed for equilibria between gaseous and condensed phases. It is shown that the difference in molal volumes of isotopic molecules is a second-order effect. The difference in mola volumes of isotopic molecules is evaluated by an extension of Gruneisen's equation of state to molecular lattices. The results are in good agreement with available experimental data.

8066 STATISTICAL MECHANICS OF MONATOMIC SYSTEM IN AN EXTERNAL PERIODIC POTENTIAL FIELD. I. INTRODUCTION, VIRIAL EXPANSION, AND CLASSICAL SECOND VIRIAL COEFFICIENT. T.L.Hill and S.Greenschlag.
J. chem. Phys. (USA), Vol. 34, No. 5, 1538-43 (May, 1961).

A general research programme is outlined which is concerne with the behaviour of an equilibrium macroscopic system (gas, liq

or solid) of monatomic molecules in an external periodic potential field. The problems of particular interest are: condensation theory; crystalline state and theory of fusion; ideal degenerate gases; distribution functions; virial expansion for a gas; and the very dilute gas. The virial expansion is discussed and the classical second virial coefficient for an adsorbed monolayer on a crystal surface is calculated as an illustration. This computation is compared with results obtained from the two conventional cases which are limiting forms of the present treatment: mobile and localized adsorption. The differences are considerable.

8067 STATISTICAL MECHANICS OF MONATOMIC SYSTEMS IN AN EXTERNAL PERIODIC POTENTIAL FIELD. II. DISTRIBUTION FUNCTION THEORY FOR FLUIDS. T.L.Hill and N.Saitô.
J. chem. Phys. (USA), Vol. 34, No. 5, 1543-53 (May, 1961).

The theory of distribution functions for monatomic systems in an external periodic potential field is outlined. Particular attention is given to the equation of state, the second virial coefficient, and the Kirkwood and Born–Green–Yvon integral equations for the distribution functions. A brief discussion of a nonperiodic external field is given in an appendix.

8068 PRESSURE FLUCTUATIONS. M.J.Klein.
Physica (Netherlands), Vol. 26, No. 12, 1073-9 (Dec., 1960).

Fluctuations for a general system are derived by the quasi-thermodynamic method. Direct statistical calculations are also given for the case of an ideal gas. The results are in agreement with those recently obtained by Wergeland (1955): the pressure fluctuations can be expressed in terms of thermodynamic properties and are statistically normal. Wergeland's arguments against an old calculation by Fowler (1936) are elaborated and confirmed.

8069 ON THE ISOLATED AND ADIABATIC SUSCEPTIBILITIES. L.Rosenfeld.
Physica (Netherlands), Vol. 27, No. 1, 67-78 (Jan., 1961).

A general discussion of the relation between the thermodynamical and statistical treatments of adiabatic transformations is carried out both on classical and quantal lines. In classical theory, the equivalence of the two treatments, and consequently the equality of the isolated and adiabatic susceptibilities, is established for very large systems, the deviations from exact equality, for any quantity, being of the order of fluctuations. In quantum theory, the similar proof of asymptotic equivalence requires an additional assumption of continuity. Conditions for exact equivalence are also discussed.

8070 GENERALIZED HARTREE–FOCK METHOD. J.G.Valatin.
Phys. Rev. (USA), Vol. 122, No. 4, 1012-20 (May 15, 1961).

A variational principle is formulated to determine the single-particle states, their pairing, and the occupation number distribution for a trial state vector of the Bardeen, Cooper, Schrieffer type (Abstr. 1708 of 1958). The equations which are derived generalize those of the Hartree–Fock method obtained with a Slater determinant trial wave-function. It is pointed out that in a suitable representation the vacuum state of a general quasi-principle transformation has such a trial form which exhibits directly the pairing of single-particle states. Another variational principle determines the excitation energies. Two coupling cases are distinguished: the commutative case in which the self-consistent densities and energies are related to quantities which all commute, and the more general noncommutative case. The latter is of importance in critical-field phenomena. The equations for the commutative case can be written in a matrix form which retains its validity in the more general noncommutative case. The simple matrix commutator equations appear as direct generalizations of the density matrix form of the Hartree–Fock equations. The equations for small oscillations have an equally simple form. Their connection with a diagonal representation of the quasi-particle energies is exhibited in a way which remains valid in the general coupling case. The "unphysical" solutions are excluded by the supplementary condition. The contact with the Green's function approach is established. The generalized matrix form of the Green's function equations shows especially clearly the symmetry properties of the method.

8071 ON THE DENSITY MATRICES USED IN HARTREE–FOCK CALCULATIONS. D. ter Haar.
Physica (Netherlands), Vol. 26, No. 12, 1041-4 (Dec., 1960).

It is pointed out that the density matrices ρHF used by quantum chemists and others in the discussion of the Hartree–Fock self-consistent field method differ from the density matrices ρSM introduced in statistical physics, and that the idempotency condition for ρHF has therefore a physical meaning which is different from the same condition for ρSM. A suggestion is made for a consistent nomenclature.

8072 EXPANSION THEOREM OF DENSITY MATRIX, VIRIAL EXPANSION AND NEW FORMULA OF MULTIPLE SCATTERING. T.Yokota.
J. Phys. Soc. Japan, Vol. 15, No. 5, 779-94 (May, 1960).

Expansion formulae are derived with the use of the calculus of ordered exponentials. Using the fomulae the expressions for virial coefficients are explicitly obtained. The expression of the third virial coefficient is calculated to obtain its expansion formula in terms of $\hbar^2\beta/M$. The expansion formulae for density matrices can be used to derive a new formula of multiple scattering, which involves Luttinger and Kohn's formula (Abstr. 5867 of 1958) as a special case. The expansion formula for the normalized density matrix is also given. Expansion formulae which are to be applied to irreversible processes and relaxation phenomena are also given.

8073 ON THE QUANTUM STATISTICAL BASIS OF NON-EQUILIBRIUM THERMODYNAMICS. J.Vlieger, P.Mazur and S.R. de Groot.
Physica (Netherlands), Vol. 27, No. 4, 353-72 (April, 1961).

The quantum statistical theory of Wigner distribution functions is developed to serve as a basis for the derivation of the Onsager reciprocal relations in non-equilibrium thermodynamics (1931). The theory is closely analogous to the classical treatment, given by de Groot and Mazur. The paper is concerned with the following topics: (1) Time dependence of Wigner distribution functions, which is described by means of a propagator. The properties of this propagator are studied. (2) Equilibrium distribution function of a set of extensive state variables, which provide a macroscopic description of the system, assuming that these variables are represented by commuting operators in quantum theory. This probability distribution function is expressed in terms of the Wigner distribution function of the microcanonical ensemble, representing thermodynamic equilibrium. The properties of distribution functions of extensive variables, in particular those with regard to the even or odd character of these variables, are studied. (3) Definition of a set of intensive thermodynamic variables, conjugate to the extensive state variables, by means of Boltzmann's entropy postulate. The theory is developed only for Maxwell–Boltzmann statistics.

8074 QUANTUM MECHANICAL SYSTEMS WITH A STOCHASTIC HAMILTONIAN. H.Primas.
Helv. phys. Acta (Switzerland), Vol. 34, No. 1, 36-57 (1961). In German.

Deals with the theory of quantum mechanical systems with a stochastic Hamiltonian, which are of importance in the theory of dissipative systems and in experimental investigations of the response of physical systems by means of electronic devices. A new formal development of quantum mechanical density matrices is given that is valid even for strong stochastic perturbations. If the stochastic part of the Hamiltonian has a Gaussian distribution and an almost constant spectral density the given solution reduces to an expansion in terms of Hermite functionals which are orthonormal with respect to the Wiener measure (Cameron–Martin development). This expansion is operationally meaningful and characterized by good convergence and simple properties. As an example of the application of the theory, a new foundation of Bloch's relaxation theory is sketched.

8075 LINKED-PAIR EXPANSIONS IN QUANTUM STATISTICS. F.Mohling.
Phys. Rev. (USA), Vol. 122, No. 4, 1043-61 (May 15, 1961).

In the quantum statistical method of Lee and Yang (Abstr. 5385 of 1959), the cluster functions of quantum statistics are expressed in terms of the cluster functions of Boltzmann statistics, which in turn are computed in terms of certain two-body functions. In the present paper, following a detailed study of the Boltzmann cluster functions, it is shown that the symmetric representation can be used for the two-body functions and that large classes of diagrams can be summed. This leads to the introduction of linked-pair graphs to describe the functions of quantum statistics. The two-body functions are expressed in terms of two-body wavefunctions, and are therefore well-defined for hard-core repulsions. For weak potentials the method is shown to be equivalent to the theory of Bloch and DeDominicis.

8076 VERY LOW-TEMPERATURE FERMI GAS. F.Mohling.
Phys. Rev. (USA), Vol. 122, No. 4, 1062-90 (May 15, 1961).

The momentum distribution in a low-temperature Fermi gas is investigated using the methods of quantum statistics developed by Lee and Yang together with linked-pair expansions (see previous abstract). It is shown that in order to determine the momentum distribution at very low temperatures, two coupled integral equations must be considered, one in momentum variables and due to Lee and Yang, and the other in temperature variables. It is also shown that the dominant low-temperature behaviour of the momentum distribution can be extracted in terms of a certain function $\nu'(\vec{k})$. For a low-density Fermi gas with strong, short-range, two-body interactions, it is shown to third order in the scattering parameters of the interaction that at T = 0 the function $\nu'(\vec{k})$ is equal to the free particle momentum distribution. Also, the energy and other thermodynamic quantities are expressed in terms of $\nu'(\vec{k})$, so that the theory permits a generalization of perturbation theoretic results to nonzero temperatures. The ground-state energy, momentum distribution, and thermodynamic potential are calculated to third order in the scattering parameters.

8077 BOSE STATISTICS IN RELATIVITY THEORY. F.Berencz.
Acta phys. chem. Szeged. (Hungary), Vol. 6, No. 1-4, 18-22 (1960). In German.

Power series for the total energy and pressure of a Bose gas of non-interacting particles are obtained from a (specially) relativistic distribution function. (cf. Abstr. 2646 of 1935; Abstr. 1443 of 1941). F.A.E.Pirani

8078 A BOUNDARY PROPERTY OF THE MEAN WAVE IN THE FUNCTIONAL THEORY OF PARTICLE SYSTEMS. J.L.Destouches.
J. Phys. Radium (France), Vol. 21, No. 3, 145-8 (March, 1960). In French.

It is shown that, under four conditions, the mean wave for a great number of particles in the nonlinear functional theory of particles obeys a linear equation with a probability very near unity. This equation is the same as the wave equation in the usual wave mechanics for the corresponding problem. Thus the linear part of the equation for the u-wave in the functional theory of particles is determined.

8079 ACTION OF THE BOLTZMANN ELASTIC COLLISION OPERATOR ON AN ISOTROPIC VELOCITY FUNCTION IN AN IMPERFECT LORENTZ GAS. E.Moreau and J.Salmon.
J. Phys. Radium (France), Vol. 21, No. 4, 217-22 (April, 1960). In French.

The Chapman and Cowling (1939) formula is reobtained and the fields in which it is valid are specified. Other expressions are proposed for fields where this formula proves to be inapplicable.

8080 COLLECTIVE MOTION IN MANY-PARTICLE SYSTEMS. II. TREATMENT OF COUPLED SYSTEMS. H.J.Lipkin.
Ann. Phys. (USA), Vol. 12, No. 3, 452-62 (March, 1961).

For Pt I see Abstr. 7310 of 1960. The previous treatment of collective motion using independent-particle wave-functions is extended to apply to cases where there is coupling between the collective modes and the other degrees of freedom of the system. The method is shown to be equivalent to the use of redundant variables and canonical transformations, but is simpler and more easily interpreted. The wave-functions are considered to be trial functions which give a good approximate description of all the degrees of freedom except the collective modes. A simple model of centre-of-mass motion with additional coupling is used to illustrate the method.

8081 METASTABLE STATES IN STRONGLY COUPLED QUANTUM SYSTEMS WITH CONTINUOUS SPECTRA. L.H.Nosanow.
Physica (Netherlands), Vol. 26, No. 12, 1124-42 (Dec., 1960).

The problem of constructing metastable states in strongly coupled quantum systems whose spectra are continuous is treated within the context of the general perturbation method developed by Van Hove (Abstr. 4847 of 1956). The state is constructed in terms of the unperturbed states and its metastable character is proved without explicitly introducing the perturbed stationary states. An interesting feature of the result is that the construction of the state requires the use of a complex number, the real part of which is equal to the energy of the state while its imaginary part is much larger than the line width of the state. The general result is applied to the Fermi gas and the Lee model. In the latter case it reduces to the result previously obtained by Glaser and Källén (1957).

8082 SIXTH VIRIAL COEFFICIENT FOR GASES OF PARALLEL HARD LINES, HARD SQUARES AND HARD CUBES. W.G.Hoover and A.G.de Rocco.
J. chem. Phys. (USA), Vol. 34, No. 3, 1059-60 (March, 1961).

The sixth virial coefficient is calculated, by a method to be reported later, and is found to be positive for hard squares and negative for hard cubes. Some earlier papers are briefly discussed. H.N.V.Temperley

8083 THEORY OF STRONGLY COUPLED MANY-FERMION SYSTEMS. I. CONVERGENCE OF LINKED-CLUSTER EXPANSIONS. L.N.Cooper.
Phys. Rev. (USA), Vol. 122, No. 4, 1021-8 (May 15, 1961).

A strongly coupled system — the limiting case of a highly degenerate many-fermion system for which the variation of the kinetic energy is neglected, and the interaction restricted to a region of momentum space neighbouring the Fermi surface — is analysed in a manner not dependent upon assumptions about the convergence of power series expansions or on partial summations of infinite series. The vacuum expectation value of the resolvent operator, $\langle 1/(H-z)\rangle_0$, is expressed as the Laplace transform of the exponential of a function linearly dependent on the volume of the system. It is shown that the linked-cluster expansion of the vacuum expectation value of the resolvent operator has a zero radius of convergence as a power series in the coupling constant. The most serious physical consequence of this is that a nontrivial interaction never results in a "normal" system.

8084 THE GENERALIZED TRANSPORT EQUATION FOR AN ELECTRON. A SOLUTION IN A SIMPLE CASE. L.van Hove and E.Verboven.
Physica (Netherlands), Vol. 27, No. 4, 418-32 (April, 1961).

The master equation to general order in the coupling responsible for the dissipative behaviour, derived in earlier papers by Van Hove, is applied to the simple case of an electron in a system of randomly distributed, static, elastic scatterers. Replacing $W_u'(k, k')$ by a constant, the equation can be solved approximately for general strength of the coupling. The solution, describing the approach to equilibrium of the electron momentum distribution, has an oscillatory character. The slightly more complicated case of an electron interacting with a vibrating harmonic lattice is also considered. It is shown how one can derive from the generalized master equation an equation describing the evolution of the electron alone, the phonons only entering through their coarse grained distribution in wave vector. Neglecting the phonon energies, one finds an equation of the same form as in the case of static, elastic scatterers.

8085 n-DIFFUSION. J.R.Philip.
Austral. J. Phys., Vol. 14, No. 1, 1-13 (March, 1961).

Transfer processes in which an entity is transferred down a gradient of a concentration-like quantity satisfy the relation $q = -A.B$, with q the flux density, A dependent on time, concentration and position, and B a function of the concentration gradient, $\nabla\theta$. In ordinary diffusion $B = \nabla\theta$. This paper considers the more general transfer process, designated n-diffusion, for which $B = |\nabla\theta|^{n-1}\nabla\theta$ ($n>0$). The paper deals with the simplest unsteady one-dimensional problem of n-diffusion (with A constant) into a semi-infinite region. The results are simply extended to the related problem in the (doubly) infinite region. Solutions are found in terms of the incomplete beta-function, though for certain values of n, solutions are expressible in terms of elementary functions. Infinite "tails" (analogous to that in 1-diffusion) occur for $0<n<1$, whilst the concentration profiles are finite for $n>1$. Distance of penetration into the region and cumulated flux vary as $(\text{time})^{1/(n+1)}$. The present paper is intended as an introduction to later work on concentration- and space-dependent forms of n-diffusion which are immediately relevant to physical problems of interest.

8086 THE DIFFUSION OF RESONANCE EXCITATION THROUGH A GAS. R.G.McIntyre and R.G.Fowler.
Astrophys. J. (USA), Vol. 133, No. 3, 1055-66 (May, 1961).

The problem of diffusion of resonance radiation has been attacked from the standpoint of a Boltzmann equation for the distribution of excited states. A solution of the problem of a uniformly excited slab of gas is obtained.

8087 ON SOLVING THE EQUATION OF RADIATIVE TRANSFER FOR CONSERVATIVE NON-UNIFORM MEDIA. P.R.Wilson.
Austral. J. Phys., Vol. 14, No. 1, 57-63 (March, 1961).

The equation of radiative transfer in a form suitable for non-uniform semi-infinite media in radiative equilibrium is solved for the attenuation coefficient κ compatible with models for total intensity J as function of two variables, subject to the boundary condition of zero inward flux at the surface.

8088 THE PRINCIPLE OF CAUSALITY AND THE SECOND LAW OF THERMODYNAMICS. J.P.Terletsky.
J. Phys. Radium (France), Vol. 21, No. 10, 681-4 (Oct., 1960). In French.

It is shown that the most reasonable interpretation of the causality principle is to consider it as a consequence of the second law of thermodynamics. It is considered, according to information theory, that a signal is a localized perturbation, transporting negentropy. In this case, the second law and the invariance interval of the universe prohibit signals faster than light. However, localized perturbations, transporting energy, and faster than light can still exist, if they do not transport negentropy, that is, if they are statistical fluctuations. Thus, particles of imaginary mass, moving with greater speed than light, can be admitted as physical realities, but the process of emission or absorption can only have the characteristics of a fluctuation, and arises without any systematical change of the entropy of the emitting or absorbing body.

GENERAL MECHANICS

8089 A COMPLEX-VARIABLE SOLUTION OF THE FIRST PROBLEM OF STATIC PLANE ELASTICITY. C.Mathurin.
C.R. Acad. Sci. (France), Vol. 252, No. 6, 843-6 (Feb. 6, 1961). In French.

The resolving equation is equivalent to a linear integral equation of the Fredholm type, with a Hermitian kernel; it can be solved, either by the method of successive approximations, or by a uniformly convergent series of complete orthogonal functions.

J.K.Skwirzynski

8090 REPRESENTATION OF THE GENERAL SOLUTION OF THE BASIC EQUATIONS OF THE STATIC THEORY OF ELASTICITY FOR AN ISOTROPIC BODY USING HARMONIC FUNCTIONS. V.I.Blokh.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 4, 473-9 (1958). In Russian.

MECHANICAL MEASUREMENTS

8091 OPTICAL SERVO CONTROL FOR A SPOON GAUGE. A.G.Grotyohann.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 345-7 (March, 1961).

A pressure gauge constructed of Pyrex glass is described which can be used for vapour pressure measurements of sulphur trioxide. The gauge automatically nulls pressure differentials across a spoon gauge by optically coupling to a servo control. Pressures up to 1 atm can be measured with an accuracy of ±0.5 mm Hg.

8092 AN AUTOMATIC COUNTER CHRONOGRAPH FOR ROUTINE MEASUREMENTS OF SHORT INTERVALS OF TIME. S.Z.R. Hashmi.
J. sci. industr. Res. (India), Vol. 20D, No. 4, 131-4 (April, 1961).

A counter which automatically records an adjustable number of time intervals is described. A feature of the device is that it is sensitive for slightly more than the interval of interest. The accuracy of time measurement is ± 1 μsec.

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

8093 RADIAL DISTRIBUTION FUNCTION OF FLUIDS. III. K.Hiroike.
J. Phys. Soc. Japan, Vol. 15, No. 5, 771-8 (May, 1960).

For Pts I and II, see Abstr. 4788-9 of 1958. A formula for the Helmholtz free energy of a one-component fluid, classical or quantum, is obtained in terms of the radial distribution function, by attaching a coupling constant to the pair interaction potential. Compatibility of the formula is discussed in connection with the formula derived in Pt II, leading to the condition to be satisfied by the radial distribution function. It is shown that the condition for compatibility is equivalent in a classical fluid to the one discussed in Pt I. The present formula is applied to deal with the hyper-netted chain approximation and the condition for compatibility is shown to be satisfied in this case. The formula is generalized to a multicomponent fluid and also to the case of a grand canonical ensemble.

STABILITY OF PRESSURE-SUPPORTED MOLTEN ZONES IN HORIZONTAL SHEETS. See Abstr. 7853

8094 APPLICATION OF THE KINETIC THEORY OF LIQUIDS TO THE STUDY OF THE VISCOSITY CURVES OF TRANSFORMER OILS. K.Piotrowski.
Bull. Sci. Assoc. Ingen. Montefiore (AIM Belgium), Vol. 73, No. 12, 759-76 (Dec., 1960). In French.

Eyring's kinetic theory of viscous flow is applied to lubricating oils of different degrees of refining. In the temperature range from 0 to 140°C, the activation energy passes through a minimum. Below the minimum the enthalpy increases linearly with falling temperature.

R.Schnurmann

8095 ON THE SLOW STEADY ROTATION OF A SPHEROID OF SMALL ELLIPTICITY IN A VISCOUS LIQUID. S.R.Khamrui.
Bull. Calcutta Math. Soc. (India), Vol. 52, No. 2, 63-7 (June, 1960).

In the case of slow steady motion of a viscous liquid due to the rotation of a sphere about a diameter, a solution was constructed by the author (1956) by a process of successive approximations, which shows that the motion consists of an inflow at the poles and an outflow at the equator. In this paper the steady rotation of a spheroid of small ellipticity in a viscous liquid is studied and adopting the same method a solution is constructed which gives a picture similar to that of the sphere.

T.C.Toye

8096 LAMINAR BOUNDARY-LAYER FLOW NEAR SEPARATION WITH AND WITHOUT SUCTION. R.M.Terrill.
Phil. Trans A (GB), Vol. 253, 55-100 (Sept. 8, 1960).

In Section I the work of Goldstein and Stewartson is extended to include suction through a porous surface. The surface function ψ_1 is expanded in a series of the type

$$\psi_1 = 2^{3/2}\xi^3 \sum_{r=0}^{6} \xi^r f_r(\eta) + 2^{3/2}\xi^8 \ln\xi[F_5(\eta) + \xi F_6(\eta)] + O(\xi^{10}\ln\xi),$$

where $\xi = x_1^{1/4}$, $\eta = y_1/2^{1/2}x^{1/4}$ and (x_1, y_1) are non-dimensional distances measured from the separation point. Analytical solutions for the functions $f_r(\eta)$ (r = 0, 1, ...,5) are obtained and the solutions for r = 0, 1, ..., 4 reduce to those given by Goldstein in the case of zero suction. The solution for $f_5(\eta)$ without suction is confirmed by comparison with the numerical work of Jones, and corrections are made to his values for two constants. The solution for $f_6(\eta)$ without suction is next considered so as to show that Goldstein's condition is not satisfied. This condition required the vanishing of a certain integral estimated by Jones at $(-4 \pm 4)\alpha_1^6$; its value is now found to be $(-8.62 \pm 0.01)\alpha_1^6$. Following Stewartson, solutions for the functions $F_5(\eta)$ and $F_6(\eta)$ are given. Numerical expansions for the skin friction and the velocity distribution near to separation are obtained. Numerical tables are given for the functions $f_3(\eta)$ and $f_4(\eta)$ and their derivatives which are required for the computation of the velocity distribution. In Section II, there is developed a numerical method, suitable for an automatic computer, by which the velocity distributions at all cross-sections to separation can be obtained from that at the leading edge. In this method Görtler's transformation is applied to the boundary-layer equations and then, by means of the Hartree–Womersley approximation, derivatives are replaced by differences. The resulting simultaneous equations are solved by an iterative pro-

cedure which involves the inversion of matrices. The programme is written so that given a general external velocity distribution and velocity of suction only a few specified subroutines are required. By this method, the boundary-layer flow is computed for the mainstream velocity $U = U_0 \sin x$ (corresponding to potential flow past a circular cylinder) and a certain constant velocity of suction. Tables are included showing the velocity distributions at selected cross-sections and giving the skin friction, displacement thickness and momentum thickness. The position of separation obtained is 114.7° from the forward stagnation point, whereas for the same suction velocity, Bussman and Ulrich gives 120.9° using a series expansion. The difference between these values is discussed and the former shown to be accurate. Near separation similar behaviour to that found by Hartree and Leigh is experienced, thus confirming the existence of a singularity at separation. The numerical results are compared with the solution given in section I and excellent agreement is obtained. The functions $f_1(\eta) \ldots f_4(\eta)$ depend on a parameter α_1, which is determined by comparing the numerical results with the asymptotic expressions for the skin friction and the velocity distribution near to separation. Both methods give $\alpha_1 \cong 0.555$. The work is repeated for the same mainstream flow $U = U_0 \sin x$ without suction. The position of separation in this case is 104.45° and $\alpha_1 \cong 0.676$. (Leigh obtained $\alpha_1 \cong 0.492$ for the mainstream flow $U = U_0(1-\frac{8}{3}x)$ without suction). A range of solutions of the equation of similar profiles is also obtained. In particular, the curve which divides the wholly forward flows from those with backflow is shown. The separation profiles for the two cases of potential flow past a circular cylinder are compared with corresponding solutions of the equation of similar profiles.

8097 QUANTITATIVE ANALYSIS OF TWO-DIMENSIONAL FLOW BY MEANS OF STREAMING BIREFRINGENCE.
S.P.Sutera and H.Wayland.
J. appl. Phys. (USA), Vol. 32, No. 4, 721-30 (April, 1961).

Streaming birefringence measurements made with tobacco mosaic virus solutions in an eccentric cylinder system are compared with an orientation theory of streaming birefringence in general two-dimensional laminar flow. It is concluded that for sufficiently dilute solutions of macromolecules with a short relaxation time, the orientation theory is valid and can be used to interpret the flow from the optical measurements, provided the complete character of the flow is known along at least one streamline.

8098 RELAXATION OF LAMINAR FLOW WITH REFERENCE TO STREAMING BIREFRINGENCE DECAY.
C.A.Hollingsworth and W.T.Granquist.
J. chem. Phys. (USA), Vol. 34, No. 5, 1814-18 (May, 1961).

Equations are obtained which express the decay of motion of fluids between concentric cylinders, parallel plates, and in tubes. Numerical examples are given which indicate that the time required for the flow to decay may not always be short compared to the streaming birefringence relaxation times.

8099 FLOW OF A CONDENSING VAPOUR WITH HEAT EXCHANGE. K.Niu.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1108-12 (June, 1960).

An analysis is given for the flow which passes through a pipe of constant cross-sectional area. The solutions obtained here are the extension of Chiarulli–Dressler's (Abstr. 8610 of 1958) and the general features of the phenomena are illustrated by an application to a flow with definite initial conditions. The two figures given by numerical calculations show distinctly the differences of the flow patterns between the supersonic and subsonic cases.

HEAT TRANSFER DURING THE FLOW OF A LIQUID METAL IN THE LAMINAR AND TRANSITION REGIONS. See Abstr. 8250

8100 THE HYPOTHESIS OF LOCALNESS IN THE TURBULENT MOTION OF A VISCOUS FLUID.
L.G.Loitsyanskii.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 5, 600-11 (1958). In Russian.

To support the differential or "local" approach to the semi-empirical study of turbulent momentum transport, the author shows that inclusion of the molecular transfer term in the Prandtl mixing length formula permits the determination of a continuous velocity profile from the boundary to the logarithmic range. Two empirical parameters are required as in the usual formulation. The author does not complete his argument that a similar continuous velocity profile can be found from the von Kármán hypothesis, where local transport is related to the first two local derivatives of the velocity. [In the opinion of the reviewer the mixing length approach is clearly not "local" when this length is taken as proportional to the distance from the boundary. The von Kármán approach is "local". If both give similar velocity profiles, what has one learned about the turbulent process?]
Mathematical Reviews

8101 CALCULATION OF A LAVAL NOZZLE.
A.Sh.Dorfman.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 3, 399-404(1958). In Russian.

An analytical solution is found for the flow in the initial supersonic part (up to Mach number 1.5) of a shock-free plane-parallel Laval nozzle, by use of a suitable approximation to the adiabatic relation in Chaplygin's hodograph equations. The stream function and its derivatives are shown to have series expansions on the sonic line similar in form to those obtained from Frankl's expressions (1945) for the solution in the subsonic region.
Mathematical Reviews

8102 A PROBLEM IN THE THEORY OF JETS.
V.P.Alekseevskii.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 6, 833-8 (1960). In Russian.

The problem considered is that of the impingement of two streams of an ideal incompressible fluid which move toward each other from infinity in the space bounded by solid walls. The motion is assumed to be steady, and symmetrical about the plane halfway between the fixed parallel walls. Using some methods of conformal mapping, a complete solution is given for this problem of plane flow, first for the case in which the bounded flow and the jet have the same density. Under certain assumptions this solution can be adapted to the case of different densities. The analogous problem in the axially symmetric case is also considered. No complete solution is obtained, but certain relations are derived by use of the law of conservation of momentum which are useful in approximate solutions of the problem.
Mathematical Reviews

8103 PLANE NOZZLE DESIGN.
I.M.Yar'ev.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 6, 839-40 (1958). In Russian.

Gives a particular solution of the approximate system of equations of motion of a gas, which is close to the Chaplygin system of equations over a wide transonic range of velocity variations. This solution can be applied to nozzle design.

8104 ON ADSORPTION AT THE OIL/WATER INTERFACE AND THE CALCULATION OF ELECTRICAL POTENTIALS IN THE AQUEOUS SURFACE PHASE. I. NEUTRAL MOLECULES AND A SIMPLIFIED TREATMENT FOR IONS.
D.A.Haydon and F.H.Taylor.
Phil. Trans A (GB), Vol. 252, 225-48 (Feb. 18, 1960).

Films of neutral substances adsorbed at the oil/water interface obey the equation of state and the adsorption isotherm which are derived assuming complete mobility of the molecules in the interface. The equations are obeyed down to areas of ~ 30 A^2 per molecule; deviations which occur below this value result from interactions between the adsorbed molecules. Adsorbed films of completely ionized sodium alkyl sulphates and quaternary ammonium compounds also obey these equations when allowance is made for the electrical contribution to the adsorption energy and for electrical interaction between the ions in the aqueous bulk phase. The activity coefficients cannot be neglected in these systems at concentrations exceeding 0.001 M. In the range 0.001 to 0.09 M the "complete" Debye–Huckel equation is used to calculate these coefficients; at the higher concentrations (for sodium decyl and octyl sulphates) the activity coefficients thus calculated are suspect. The electrical energy is given exactly by a modified Gouy equation, when allowance is made for the film ions being situated a finite equilibrium distance from the interface and for the fact that counter-ions will be present above the head groups. This modified equation yields linear plots for the isotherms and leads to consistent values for the free energy of adsorption of the molecules. It also (a) demonstrates that the electrical potential at the phase boundary (ψ_d) differs from that in the plane for the film ions (ψ_o) and that the true ψ_o is lower than that calculated from the simple Gouy equation; from the measured surface potentials (ΔV) interpreted by the equation of Schulman and Hughes (1932), it is shown that the calculated ψ_d is experimentally confirmed; (b) predicts much more accurately than the simple equation the relation between the observed surface pressure (Π) and area per molecule (equation of state). Deviations from the equations occur for short-chain com-

pounds (C_8 and C_{10}) in water at high concentrations, and for all surface-active agents in high electrolyte concentrations (> M/100), especially where A < 70 A^2. It is concluded that these deviations result mainly from a neglect of ionic size in the theoretical treatment. There is no evidence in any of the systems for any specific interaction between counter ions and adsorbed film ions. The experimental results are inconsistent with the view that appreciable energy changes associated with dehydration of the surface-active ions occur as they approach the oil/water interface.

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

STUDY OF THE [LATTICE] DYNAMICS OF SOLID AND OF LIQUID MEDIA BY SLOW NEUTRON SPECTROMETRY. See Abstr. 7525

8105 RADIAL DISTRIBUTION FUNCTION FROM THE PERCUS–YEVICK EQUATION. A.A.Broyles.
J. chem. Phys. (USA), Vol. 34, No. 3, No. 3, 1068 (March, 1961).

The Percus–Yevick integral equation is solved numerically and compared with the Monte-Carlo solution obtained by Wood and Parker (Abstr. 9668 of 1957) for a Lennard-Jones interaction. This solution is found to agree much better with the Monte-Carlo results than does the corresponding solution of the Born–Green equation. H.N.V.Temperley

8106 THEORY OF SOLUTIONS OF CHAIN MOLECULES. H.Okamoto.
J. Phys. Soc. Japan, Vol. 15, No. 4, 650-7 (April, 1960),

Using the first order Bethe approximation, a theory of solution of chain molecules is developed. Though it is a well-known fact that the first order Bethe approximation and the method of the quasi-chemical equilibrium coincide with each other for the case of a lattice gas or solutions of short chain, this coincidence is found to be not always true for solutions of long chain molecules. The results obtained agree with experimental data.

8107 DENSITY OF LIQUID NITROGEN AND ARGON AS A FUNCTION OF PRESSURE AND TEMPERATURE. A. van Itterbeek and O.Verbeke.
Physica (Netherlands), Vol. 26, No. 11, 931-8 (Nov., 1960).

Experimental results on the density of liquid nitrogen and argon as a function of temperature and pressure are given from 90° to 65°K for liquid nitrogen and from 90° to 86°K for liquid argon, both up to 150 kg/cm^2. A quadratic function is found for the density of the gas as a function of pressure. From these experimental results are calculated some thermodynamic properties as γ, Poisson's ratio, and W, the velocity of sound. Finally results are compared with the existing ones on those thermodynamic functions.

8108 PVT RELATIONS OF FIVE LIQUID n-ALKANES. J.W.M.Boelhouwer.
Physica (Netherlands), Vol. 26, No. 11, 1021-8 (Nov., 1960).

PVT relations of liquid heptane, octane, nonane, dodecane and hexadecane were measured at four temperatures between 30° and 120°C and at pressures up to 1200 kg/cm^2, using a bellows method. The estimated accuracy in the relative volume is ± 0.0004. All measurements fit the Hudleston equation (1937) relating pressure and volume at constant temperature. Via this equation isothermal compressibilities of the liquid at the measuring conditions were calculated. In general, the measurements are in good agreement with those reported earlier. Isochores calculated from the measurements show a linear relation between pressure and temperature in agreement with the findings of Eduljee et al. (1951).

8109 EXCESS THERMODYNAMIC PROPERTIES OF THE LIQUID SYSTEMS O_2–A AND O_2–N_2.
C.M.Knobler, R.J.J.van Heijningen and J.J.M.Beenakker.
Physica (Netherlands), Vol. 27, No. 3, 296-309 (March, 1961).

The heats of mixing for the systems O_2–N_2 at 77°K and O_2–A at 86°K are reported. These, in conjunction with values of the excess Gibbs free energy calculated from vapour–liquid equilibrium data, are used to evaluate the excess entropy. Neither of the mixtures is regular. The application of corresponding state theories of liquid mixtures to these systems is considered as a method for calculating the excess thermodynamic functions.

8110 THE VOLUME CHANGE ON MIXING FOR SEVERAL LIQUID SYSTEMS AND THE DIFFERENCE IN MOLAR VOLUME BETWEEN THE ORTHO AND PARA MODIFICATIONS OF THE HYDROGENIC MOLECULES.
H.F.P.Knaap, M.Knoester and J.J.M.Beenakker.
Physica (Netherlands), Vol. 27, No. 3, 309-18 (March, 1961).

Measurements were performed for the systems O_2–N_2, O_2–A, normal H_2–normal D_2, normal H_2–para H_2 and normal D_2–ortho D_2. Furthermore, the difference in molar volume between normal H_2 and para H_2 and between normal D_2 and ortho D_2 was determined. The accuracy is of the order of 5 mm^3 per mole.

8111 THERMODYNAMIC PROPERTIES OF LIQUID SILVER–LEAD ALLOYS, WITH AN APPENDIX ON THE VAPOUR PRESSURE OF LEAD. A.T.Aldred and J.N.Pratt.
Trans Faraday Soc. (GB), Vol. 57, Pt 4, 611-18 (April, 1961).

Using a torsion–effusion method, vapour pressures of lead were measured over liquid silver–lead alloys and the results used to compute their thermodynamic properties. The system is found to exhibit positive heats and positive excess entropies of formation. The results are compared with other thermodynamic data and it is concluded that the specific heats of the alloys deviate positively from Neumann–Kopp behaviour. The properties of this and other lead base systems are compared and the influence of solute valency and ionic size on the partial properties of lead are discussed. The vapour pressure of pure lead has been remeasured in the range 880°–1050°K.

8112 ON THE THERMOELASTIC WAVES IN LIQUIDS. É.I.Takizawa.
Acustica (Internat.), Vol. 10, No. 1, 25-9 (1960).

For a system showing relaxation phenomena, a calculation is made for the isothermal case of small relaxation coefficients of the specific heat and thermal conductivity according to both the Debye and the Brillouin theories. The theoretical results agree, in the special case of a system having shear viscosity closely with the expressions obtained by Lucas (1957, 1959).

8113 DIFFUSION IN A LIQUID INDIUM–TIN ALLOY AT SEVERAL CONCENTRATIONS.
A.Paoletti and M.Vincentini-Missoni.
J. appl. Phys. (USA), Vol. 32, No. 4, 559-61 (April, 1961).

Self-diffusion coefficients for both In^{114} and Sn^{113} as tracers were measured in the liquid In–Sn alloy at several concentrations. The temperature range investigated was 200°-600°C. The dependence of diffusiveness on temperature at constant composition can be represented by the customary Arrhenius equation for all the compositions investigated. The variation of diffusiveness with composition at constant temperature was also examined, and it gives evidence of a large difference in the behaviour of the two tracers.

8114 INTERACTION BETWEEN ROD-LIKE POLYELECTROLYTES. T.Ohnishi, N.Imai and F.Oosawa.
J. Phys. Soc. Japan, Vol. 15, No. 5, 896-905 (May, 1960).

A system of rod-like polyelectrolytes in a salt-free solvent is treated systematically. The force between two rods arranged parallel in their free volume is obtained, as a function of their charge density and the distance between them, by using the exact solution of the Poisson–Boltzmann equation for this system and the general expression of force by Bell and Levine [Trans Faraday Soc. (GB), Vol. 54, Pt 6, 785-99 (June, 1958)]. Numerical examples are given under various conditions of charge and distance. At high charge, the force between charged rods is greatly depressed by counter ions around the rods even at the short mutual distance. Owing to the neutrality condition a force which is called the neutrality force appears between rods. This force makes stable the equidistant arrangement of many rods in the solution. Simpler models — plate, one rod, and pipe — are also treated and a general theory on the force in cylindrical coordinate systems is developed. As a result, the effect of counter ions on the force between charged particles is clearly understood.

8115 THE RELATION BETWEEN THE GULDBERG LAW AND THE TEMPERATURE VARIATION OF THE VELOCITY OF SOUND IN LIQUIDS. W.Schaaffs.
Acustica (Internat.), Vol. 10, No. 3, 160-6 (1960). In German.

The velocity of sound decreases in direct proportion to temperature in most liquids and melts. With the help of the work

hypothesis (linear extrapolation above the boiling point strikes the parabolic curve of the gas phase at a point corresponding to the critical temperature), a formula is deduced according to which the temperature coefficient of the velocity in a liquid is proportional to that at the boiling point and inversely proportional to the absolute value of the boiling temperature. The factor of proportionality is calculated for organic liquids, condensed gases, molten metals and alkali salts. The factor is closely related to the quotient of the Guldberg rule.

VIBRATIONAL RELAXATION IN LIQUID CHLORINE.
See Abstr. 8161

DIELECTRIC PROPERTIES OF DILUTE POLYMER SOLUTIONS. See Abstr. 7681

8116 ULTRASONIC VELOCITIES IN SOME BINARY MIXTURES OF BENZYL ALCOHOL.
H.S.Ramo Rao and B.Ramachandra Rao.
J. sci. Industr. Res. (India), Vol. 20B, No. 4, 157-60 (April, 1961).

Studies were carried out in liquid mixtures of benzyl alcohol with n-butyl alcohol, isobutyl alcohol, sec-butyl alcohol, tert-butyl alcohol, ethylene glycol, glycerol, cyclohexanol and phenol. The were calculated for liquid mixtures, and it was found the molar sound velocity varies linearly with molar fraction in spite of the non-linear variations in the velocity and density in some of the mixtures. The variation of velocity and adiabatic compressibility are explained on the basis of intermolecular forces.

8117 VELOCITY OF ULTRASONIC WAVES IN LIQUID NORMAL AND PARA HYDROGEN.
A.Van Itterbeek, W.Van Dael and A.Cops.
Physica (Netherlands), Vol. 27, No. 1, 111-16 (Jan., 1961).

The velocity depends upon the ortho–para concentration in the liquid. Between 14 and 20°K the velocity in a 99.8% para mixture is about 8 m/sec or about 0.6% smaller than in the 25% mixture. In the frequency range from 1 to 5 Mc/s no influence of frequency could be detected. During the measurements one did not find any spontaneous conversion activated by the ultrasonic energy. The adiabatic compressibility of the equilibrium mixture surpasses that of the normal hydrogen by about 20%.

8118 ULTRASONIC TRANSMISSION IN HEATED LIQUIDS. R.Pohlman.
Acustica (Internat.), Vol. 10, No. 4, 229-37 (1960). In German.

Ultrasonic transmission in water increases as the temperature is raised to the boiling point (together with some hysteresis in this factor) in spite of the expected fall due to increasing vapour pressure. The form of the temperature dependence, but not of the absolute values of the ultrasonic propagation at high temperatures, agrees with previous ideas.

8119 APPLICATION OF A THEORY OF NONIDEAL SOLUTIONS TO RESULTS OF ULTRASONIC ABSORPTION MEASUREMENTS. F.O.Goodman.
J. chem. Phys. (USA), Vol. 34, No. 5, 1585-9 (May, 1961).

It is shown that results of ultrasonic absorption measurements on solutions can sometimes be explained by application of a theory of nonideal solutions when the corresponding ideal-solution theory is inadequate. The results of ultrasonic absorption in tertiary butanol solutions in cyclohexane reported by Musa and Eisner (Abstr. 5453 of 1959) are studied using a theory of nonideal solutions. This differs from the corresponding ideal-solution theory by the appearance of terms proportional to the derivatives of the ratio (k/l) of the relevant rate constants with respect to the concentration of the solute. In ideal solutions, these derivatives are zero. It is assumed that monomers and dimers are the only complexes present and it is concluded that a perturbation of the monomer–dimer equilibrium is responsible for the measured "excess absorption". The nonideality of the solutions is discussed, and a "nonideality coefficient" is introduced. A comparison with the imperfect gas theory of Tabuchi is made.

8120 ON THE INTRAMOLECULAR LIGHT SCATTERING OF THE NON-GAUSSIAN CHAIN. A.Miyake.
J. Phys. Soc. Japan, Vol. 15, No. 5, 875-82 (May, 1960).

The function $P(\theta)$ is investigated. For small values of $s = (4\pi/\lambda)\sin(\theta/2)$, where λ is the wavelength of light in the solution, θ the scattering angle, $1/P(\theta)$ is given by $1 + (s^2/3)\langle r_G^2\rangle$, and $\langle r_G^2\rangle$ the mean square radius of gyration from the centre of mass can be calculated according to various theories. For sufficiently large values of s, $1/P(\theta)$ is expanded in terms of $1/s^2$ so as to obtain the asymptotic behaviour of $1/P(\theta)$ versus $\sin^2(\theta/2)$. Excluded volume and swelling effects on $1/P(\theta)$ are discussed in a general way. The asymptotic behaviour for large s of the experimental results of Cantow–Schulz (1954) is analysed according to the theory.

8121 THEORY OF ELECTRIC BIREFRINGENCE IN DILUTE SOLUTIONS OF TOBACCO MOSAIC VIRUS.
S.Ogawa and S.Oka.
J. Phys. Soc. Japan, Vol. 15, No. 4, 658-68 (April, 1960).

Calculation of the electric birefringence in dilute solutions of tobacco mosaic virus in alternating fields with the aid of the distribution functions following the work of O'Konski and Haltner [J. Am. Chem. Soc., Vol. 79, 5934 (1957)]. The theory is in agreement with the experimental results in that (1) the phase retardation of the birefringence relative to the field is proportional to the frequency, (2) the maximum and minimum values of the steady-state birefringence are unity and zero at zero frequency, and both values become asymptotically 1/2 with increasing frequency, and (3) the magnitude of birefringence decreases rapidly when the frequency is increased beyond 30 kc/s.

8122 VALIDITY OF THE CRYSTAL FIELD THEORY FOR THE STUDY OF TRANSITION METAL IONS IN AQUEOUS SOLUTION. ABSORPTION SPECTRUM OF THE BIVALENT VANADIUM ION. J.Michielsen-Effinger.
C.R. Acad. Sci. (France), Vol. 252, No. 5, 673-4 (Jan. 30, 1961). In French.

It is shown that only a field of octahedral symmetry, attributed to perturbation by surrounding water molecules, can explain satisfactorily this spectrum. This is strongly in favour of the crystal field theory. J.Hawgood

8123 NEAR-ULTRAVIOLET SOLUTION SPECTRA OF PYRIDAZINE. R.H.Linnell.
J. chem. Phys. (USA), Vol. 34, No. 2, 698-9 (Feb., 1961).

Hydrogen bonding is used to explain the solvent shift of the long wavelength ultraviolet band of pyridazine in changing from hydrocarbon solvent to water. G.I.W.Llewellyn

8124 SOLVENT EFFECTS ON THE SPECTRA OF HALIDE IONS. S.J.Strickler and M.Kasha.
J. chem. Phys. (USA), Vol. 34, No. 3, 1077-8 (March, 1961).

Positions of absorption maxima of Cl, Br and I ions depend greatly on the solvent and in mixed solvents (ethanol/acetonitrile) shift continuously between the positions for the pure solvents. This supports the theory that the excited electron is in the average field of the surrounding solvent molecules. Solvent shifts for NO_2 and NO_3 ions are not similar and are therefore assigned to internal transitions in the molecules. G.F.Lothian

8125 CALCULATION OF PRESSURE SHIFTS OF OPTICAL ABSORPTION SPECTRA FROM SOLVENT DATA.
W.W.Robertson and A.D.King, Jr.
J. chem. Phys. (USA), Vol. 34, No. 5, 1511-15 (May, 1961).

Frequency shifts in the absorption spectra of both polar and nonpolar absorbers were observed at atmospheric pressure in a range of polar and nonpolar solvents and in pentane and ethanol under hydrostatic pressures up to 5000 atm. McRae's equation representing frequency shifts in terms of solvent refractive index and dielectric constant can be modified by the use of the Debye equation to represent frequency shifts in terms of solvent density. If it is assumed that the volume of the cavity occupied by the absorber remains constant with solvent density, frequency shifts resulting from an increase in hydrostatic pressure can be calculated almost to within the limit of experimental error from solvent shift data.

8126 CONTRIBUTIONS TO THE QUESTION OF THE SPECTRAL EFFECT OF SECONDARY FLUORESCENCE. A.Budó, J.Dombi and R.Horvai.
Acta phys. chem. Szeged (Hungary), Vol. 3, No. 1-4, 3-15 (1957). In German.

A mathematical investigation of the effect of secondary fluorescence, arising from absorption of the primary emission, on the measured output of solutions. It is shown that the derived equations give a curve for the true spectral emission of fluorescein which is very nearly the same in six different experimental cases, which involved excitation by alternative ultraviolet wavelengths, with measurement of the output transversely as well as longitudinally at the front and back faces of the liquid cell. S.T.Henderson

8127 A SIMPLE EXPERIMENTAL METHOD FOR THE DETERMINATION OF THE INTENSITY OF SECONDARY FLUORESCENCE. J.Dombi, J.Hevesi and R.Horvai.
Acta phys. chem. Szeged (Hungary), Vol. 5, No. 1-2, 20-5 (1959). In German.

A method of calculating the ratio between secondary and primary fluorescence in a solution. Four organic dyes were used over a range of concentration from 5.6×10^{-6} to 5.6×10^{-4} moles/litre, the degree of polarization being negligible. Curves show the increase from zero of the ratio (secondary emission/primary) with increasing concentration. The ratio is higher for larger overlap of the absorption and emission bands, which also are figured.
S.T.Henderson

8128 A NEW PHOTOELECTRIC APPARATUS FOR THE INVESTIGATION OF FLUORESCENCE POLARIZATION. I.Ketskeméty, L.Gargya and E.Salkovits.
Acta phys. chem.Szeged.(Hungary), Vol. 3, No. 1-4, 16-20 (1957). In German.

The liquid is excited by polarized 4358 A radiation and the emergent fluorescent light split by a Wollaston prism into two beams polarized at right angles, each being reflected into its own photomultiplier. The degree of depolarization, and hence of polarization, is determined from the amplified p.d. between the two detectors, which have suitable external circuits. Errors due to penetration of the exciting radiation to the photomultipliers are considered, and measurements on fluorescein in glycerin–water are shown to agree well with the theoretical depolarization curve (see Abstr. 14661 of 1960).
S.T.Henderson

8129 OBSERVATIONS ON THE QUESTION OF FLUORESCENCE POLARIZATION. A.Budó and I.Ketskeméty.
Acta phys. chem. Szeged.(Hungary), Vol. 4, No. 3-4, 86-9 (1958). In German.

A critical examination of an empirical method of Vavilov (1937) for determining the true degree of polarization of fluorescence in solution from measurements of the apparent polarization. This is considered less reliable than the authors' more complicated method of calculation (Abstr. 14661 of 1960).
S.T.Henderson

8130 THE EXPERIMENTAL INVESTIGATION OF ROTATION DEPOLARIZATION OF THE FLUORESCENCE OF SOLUTIONS. L.Gáti and L.Szalay.
Acta phys. chem. Szeged.(Hungary), Vol. 4, No. 3-4, 90-3 (1958). In German.

The Perrin–Levshin formula for degree of polarization p in terms of absolute temperature T, viscosity η, decay time, and volume of the fluorescing molecule, does not agree with experiment at low values of η. Correction for secondary fluorescence, however, gives a closely linear relation between $1/p$ and T/η.
S.T.Henderson

8131 TRANSIENT DIMER FORMATION BY 2,5-DIPHENYLOXAZOLE. I.B.Berlman.
J. chem. Phys. (USA), Vol. 34, No. 3, 1083-4 (March, 1961).

The occurrence of this in solution as the concentration is increased is indicated by: (1) change in the spectrum of fluorescent emission and (2) increased fluorescent lifetime. The absorption spectrum is independent of concentration so that the dimer is not permanent.
G.F.Lothian

8132 THE DIELECTRIC CONSTANT OF IDEAL MIXTURES OF LIQUIDS. D.Decroocq and J.C.Jungers.
C.R. Acad. Sci. (France), Vol. 252, No. 10, 1454-6 (March 6, 1961). In French.

An expression is given for the dielectric constant based on an application of the Onsager–Kirkwood theory to binary mixtures in which the molecules preserve their volumes, dipole moments and the degree of dissociation which they had in their pure states. The dielectric constant so calculated varies as a function of volumetric composition, linearly for polar substances and quasi-linearly for mixtures with one or two non-polar components. Good agreement with experiment is found for ideal mixtures (as assessed by physico-chemical properties).
R.G.C.Arridge

8133 TEMPERATURE DEPENDENCE OF THE PERMITTIVITY. L.Andrussow.
Z. phys. Chem. (Germany), Vol. 215, No. 5-6, 373-80 (1960). In German.

The permittivity of a number of polar liquids is fitted to the empirical formula $\epsilon = KT^n$, where K is a constant and n is a slowly varying function of the temperature T. The author comments on the value and the temperature variation of n but offers no theoretical justification for his choice of formula.
K.W.Plessner

8134 THE HALL COEFFICIENT OF LIQUID MERCURY. N.Cusack and P.Kendall.
Phil. Mag. (GB), Vol. 6, 419-27 (March, 1961).

A technique for measuring the Hall coefficient of liquid metals is described. Results for solid and liquid mercury are presented and discussed. The Hall coefficient for liquid mercury is found to be -75×10^{-5} e.m.u. over the temperature range -38.9° to $+100^\circ$C.

8135 IDENTIFICATION OF PERINAPHTHENE RADICAL IN PETROLEUM PRODUCT. F.C.Stehling and K.W.Bartz.
J. chem. Phys. (USA), Vol. 34, No. 3, 1076-7 (March, 1961).

The e.s.r. spectrum corresponding to about 10^{-4} mole/l. of free radicals was obtained from catalytic cycle stock. The g value, the number of peaks, and the splitting between peaks appear to be identical to those reported for the perinaphthene radical by Sogo et al (Abstr. 8057 of 1957).
J.M.Baker

8136 DEGASSING OF LIQUIDS FOR NUCLEAR SPIN–LATTICE RELAXATION STUDIES. J.Lees, B.H.Muller and J.D.Noble.
J. chem. Phys. (USA), Vol. 34, No. 1, 341-2 (Jan., 1961).

A gettering technique is described for the removal of dissolved oxygen. Spin–lattice relaxation times measured for degassed pentane, hexane, and heptane are several times longer than previously reported values, which must therefore refer to impurity relaxation. The technique may not be useful for the degassing of water.
E.F.W.Seymour

8137 NUCLEAR SPIN RELAXATION AND MOLECULAR DIFFUSION IN LIQUID HYDROGEN. W.P.A.Hass, G.Seidel and N.J.Poulis.
Physica (Netherlands), Vol. 26, No. 10, 834-52 (Oct., 1960).

The nuclear spin lattice relaxation time T_1 and the diffusion coefficient D of liquid hydrogen were measured between 14° and 20°K by the spin echo technique. The temperature dependence of the quantities does not agree with recent predictions of their behaviour. The observed dependence of T_1 on ortho hydrogen concentration indicates that the reorientation of the ortho molecules within the liquid is best explained in terms of a collision theory description. An appendix is devoted to a discussion of the influence of diffusion on spin echoes.

8138 NUCLEAR MAGNETIC SPIN–LATTICE RELAXATION BY SPIN–ROTATIONAL INTERACTIONS. H.S.Gutowsky, I.J.Lawrenson and K.Shimomura.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 349-51 (April 1, 1961).

Experimental evidence that spin–rotational interactions provide the dominant spin–lattice relaxation mechanism in certain molecular liquids is presented. Results are given for CH_2FCl, CHF_2Cl, and CHF_3, and less extensively for $CHFCl_2$. The interpretation of the relaxation times, which are much shorter than expected, in terms of spin–rotational interactions is supported by the temperature dependence of the relaxation time and the fact that the fluorine is much more affected than the protons.
J.M.Baker

8139 SOLVENT EFFECTS IN NUCLEAR MAGNETIC RESONANCE. R.J.Abraham.
J. chem. Phys. (USA), Vol. 34, No. 3, 1062-4 (March, 1961).

It is shown that the differences between the proton chemical shifts of CH_4 and CH_3CN, respectively, in a variety of solvents (Buckingham et al, Abstr. 7801 of 1960) can be attributed to the reaction fields produced by the distortion of the solvent molecules by the polar solute CH_3CN. The analysis avoids large but uncertain corrections for bulk diamagnetism.
E.F.W.Seymour

8140 SOLVENT EFFECTS IN NUCLEAR MAGNETIC RESONANCE. A.D.Buckingham, T.Schaefer and W.G.Schneider.
J. chem. Phys. (USA), Vol. 34, No. 3, 1064-5 (March, 1961).

The failure of the analysis described in the preceding abstract in the case of benzene as solvent is discussed in terms of a possible specific molecular interaction between the solute CH_3CN and solvent molecules.
E.F.W.Seymour

8141 DENSITY VERSUS CHEMICAL SHIFT IN N.M.R. SPECTRA. S.Gordon and B.P.Dailey
J. chem. Phys. (USA), Vol. 34, No. 3, 1084-5 (March, 1961).

For gaseous and liquid methane and ethylene the proton resonances are shifted to lower fields by amounts which increase linearly with the density, and which are greater than can be due to changes of diamagnetic susceptibility alone. The extra shifts are attributed to van der Waals forces. E.F.W.Seymour

8142 SECOND-ORDER EFFECTS IN LOW-FIELD N.M.R. FOR AMMONIUM ION SOLUTIONS.
R.J.S.Brown and D.D.Thompson.
J. chem. Phys. (USA), Vol. 34, No. 5, 1580-3 (May, 1961).

Low-field free-precession signals from aqueous ammonium nitrate solutions show a complex beat pattern containing the 52.55 c/s first-order spin–spin splitting observed at high fields and also a 1.35 c/s second-order splitting when the proton precession frequency is 2137 c/s. The T_1 is slightly longer for the ammonium hydrogen than for the water hydrogen; T_2 is shorter than T_1 for the ammonium hydrogen and is shorter for the outer lines than for the central line.

8143 PROTON RESONANCE SHIFTS IN ALKALI HALIDE SOLUTIONS. B.P.Fabricand and S.Goldberg.
J. chem. Phys. (USA), Vol. 34, No. 5, 1624-8 (May, 1961).

Proton magnetic resonance shifts in alkali halide solutions with respect to distilled water were measured as a function of ionic charge, radius, and concentration. The shifts are linear with concentration up to a certain concentration depending on the salt. In this linear range, the shifts due to each ion are independent of one another and can be obtained by arbitrarily assuming the shift of the chloride ion to be zero. The ionic shifts so obtained are linear with the ionic crystal radius for anions and cations at a given salt concentration. Results are presented showing that the time-averaged packing of the ions is closer than if they were arranged on a cubic lattice and that the ionic effects on the proton shielding do not extend past nearest-neighbour water molecules.

8144 NUCLEAR MAGNETIC RESONANCE STUDY OF PROTON EXCHANGE IN ALCOHOL-WATER MIXTURES. M.G.Mavel.
J. Phys. Radium (France), Vol. 21, No. 10, 731-42 (Oct., 1960). In French.

In non-electrolytic mixtures, two essential means of exchange can be distinguished: the first due to the lability of complexes (mean life $\sim 10^{-10}$sec); the second, much slower, is attributed to a double interaction of dipoles (mean life $\sim 10^{-3}$sec). From that point of view, the different kinds of exchange are examined which can occur in a mixture water-alcohol (composed of polymers of varying size, and of water alcohol complexes); the correlation of the results with energy data is attempted. A detailed description is given of an extensive experimental study, compared with data on the different alcohols. It shows a direct dependence with length and branching of the alkyl chains and with the degree of inter or intra molecular association.

MECHANICS OF GASES

8145 VISCOSITY OF POLAR GASES.
K.M.Joshi and S.C.Saxena.
Physica (Netherlands), Vol. 27, No. 3, 329-36 (March, 1961).

Viscosity data are interpreted in terms of a modified Stockmayer potential. Potential parameters are evaluated by a graphical method. Computed values of viscosity are compared with the experimental data as functions of temperature. This procedure throws some light on the nature of intermolecular forces and leads to the conclusion that the modified potential can be relied upon only for moderately polar gases. For highly polar gases, this potential may at best serve the purpose of an empirical correlating function for the experimental data.

8146 N.M.R. MEASUREMENT OF GAS COMPRESSIBILITY.
M.Lipsicas, M.Bloom and B.H.Müller.
J. chem. Phys. (USA), Vol. 34, No. 5, 1813-14 (May, 1961).

The nuclear magnetic resonance technique was applied to measurement of the compressibility factors of gases. Some results are given for CH_4 and compared with data available in the literature.

8147 WALL PRESSURE CORRELATIONS IN TURBULENT AIRFLOW. D.H.Tack, M.W.Smith and R.F.Lambert.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 410-18 (April, 1961).

The correlation properties of turbulent wall pressure fluctuations are investigated experimentally with a view toward developing an adequate phenomenological model of the pressure correlation function for use in engineering calculations. It was found that both mean eddy sizes and mean eddy lifetimes determined by averaging over broad frequency bands did not contain sufficient information accurately to describe the high frequency end of the turbulent power spectrum. Thus, such gross quantities are of somewhat limited utility in detailed analysis, for instance, in predicting response of multimodal mechanical systems driven by flowing turbulence. However, by measuring eddy sizes and lifetimes over narrow frequency bands it appears possible to construct mathematical models for the turbulent pressure correlations which are successful in predicting the turbulent power spectrum over the frequency band of interest which could include the entire spectrum. In addition, measurements of r.m.s. pressure and space-time correlations are presented which supplement the data obtained by Willmarth (1959) for a somewhat higher mach range.

8148 UNSTEADY MOTION OF A GAS DRIVEN OUT BY A PISTON NEGLECTING THE COUNTER-PRESSURE.
N.N.Kochina and N.S.Mel'nikova.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 4, 444-51 (1958). In Russian.

A piston moves symmetrically into a stagnant gas in ν dimensions so that its displacement from the origin at time t is $[c/(m+1)]t^{m+1}$, where c is a constant. The motion of the gas ahead of the piston and behind the resulting shock is investigated on the assumption that the pressure in the stagnant gas is negligible. Dimensional analysis of the three governing partial differential equations and of the boundary conditions at the piston and at the shock reveals that self-similar solutions for the dependent variables are available in terms of λ, the dimensionless combination $(ct^{m+1})/r$ (here r is the distance from the origin). Three ordinary differential equations result for the non-dimensional quantities V (gas velocity), R (gas density) and Z (sound velocity) as functions of λ. Elimination of R and λ yields a non-linear differential equation in the (Z, V) plane. A thoroughgoing topological analysis of the solution curves in this plane is made in terms of the several possible critical points of the differential equation. The character of these critical points changes as m ($m > -1$), ν and γ (the ratio of the specific heats) vary. Four characteristic ranges of m are noted but not all of these give rise to physical solutions. Solutions are provided in the form of graphs to illustrate the various cases and are interpreted physically. The equivalence of the problem with that of steady hypersonic flow past slender bodies is noted.
Mathematical Revie

Shock Waves

8149 SHOCK-WAVE EQUATIONS IN A SLIGHTLY DISSIPATIVE FLUID IN UNSTEADY MOTION.
P.Germain and J.P.Guiraud.
C.R. Acad. Sci. (France), Vol. 252, No. 8, 1101-3 (Feb. 20, 1961). French.

The work of an earlier note (Abstr. 10730 of 1960) is extended to the case of unsteady flow. The equations of motion are written down, and it is assumed that all the magnitudes involved have the same functional form as one passes through the shock. It is claimed that the resulting equations can be solved by successive approximation, starting with the "classical"solution of the shock-wave problem.
H.N.V.Temperle

8150 FLOW PHENOMENA ASSOCIATED WITH A SUPERSONIC WAVE. VERIFICATION (IN A SHOCK TUBE) OF THEORETICAL PREDICTIONS. F.Canac and M.Merle.
Acustica (Internat.), Vol. 10, No. 1, 14-24 (1960). In French.

After a brief review of shock tube theory, an experimental study, using an electronic camera, is described. This shows clearly the succession of phenomena in the tube and the effect of the initial pressure and tube length. A preliminary critical comparison is made of the mathematical theory and the experimental results. The advantages of the use of shock tubes are enumerated.

GASEOUS STATE

8151 DENSITY MEASUREMENTS IN REFLECTED SHOCK WAVES. W.C.Gardiner, Jr and G.B.Kistiakowsky.
J. chem. Phys. (USA), Vol. 34, No. 3, 1080-1 (March, 1961).

The state of the gas behind a reflected shock wave may be calculated by the simple theory of shock wave reflection, but recent experimental results have thrown some doubt on the accuracy of this procedure in certain circumstances. This paper reports relevant experiments with 99.995% pure xenon, with reflected shock temperatures from 3000 to over 7000°K, indicating that the measured densities immediately behind the reflected shocks do agree with the calculated values to within the experimental accuracy.
N.Curle

8152 INSTRUMENT TO MEASURE DENSITY PROFILES BEHIND SHOCK WAVES. W.J Witteman.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 292-6 (March, 1961).

An optical method for the quantitative study of the density distribution behind shock waves was developed. The method, which uses a photoelectric recording, is based upon the integrated schlieren method originally devised by Resler and Scheibe. A detailed theoretical analysis is given. Excellent agreement with predicted performance was found in measurements of the density profiles behind shock waves in CO_2. The method is very accurate and retains its high sensitivity for weak shocks. The pictures obtained show a nearly exponential approach to equilibrium of the density behind shock waves.

8153 SCHLIEREN OPTICAL INVESTIGATION ON LARGE-AMPLITUDE AIRBORNE SOUND WAVES IN TUBES. H.Schlemm.
Acustica (Internat.), Vol. 10, No. 4, 237-45 (1960). In German.

A plane sound wave of large amplitude and low frequency becomes deformed in its passage along a pipe until a weak shock front is set up. The pressure jumps in the shock wave can be photographed by a schlieren method and measured on an oscillograph. The schlieren pictures also enable the characteristics of the wave front at an obstacle to be investigated.

8154 STRUCTURE OF WEAK SHOCK FRONTS IN ARGON–HELIUM MIXTURES. W.H.Andersen and D.F.Hornig.
Phys. of Fluids (USA), Vol. 4, No. 5, 650-1 (May, 1961).

Diffusion increases shock front thickness by 70% in a mixture containing 40% helium.
E.R.Wooding

8155 NONLINEAR REFLECTION OF WEAK SHOCK WAVES. O.S.Rȳzhov and S.A.Khristianovich.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 5, 586-99 (1958). In Russian.

An analysis is presented for a phenomenon which the authors describe as "short waves". Such a wave is a narrow region in the flow behind a weak shock wave in which the pressure gradients are so large that the propagation of the shock wave is not governed by the usual acoustic approximation but can be determined only with due allowance made for the interaction between the shock and short wave. The general non-linear equations which represent a valid approximation to the full equations are derived and particular solutions of these approximate equations are obtained by similarity methods. The problem of reflection of weak shock waves from a rigid plane surface is then considered for the case when the angle of incidence is near the critical value for the breakdown of regular reflection. In this problem, short waves exist close to the point of reflection but the boundary conditions are not satisfied by any of the class of similarity solutions. The authors take as their solution the one which most nearly satisfied an equation of conservation of momentum.
Mathematical Reviews

SHOCK INITIATION OF DETONATION IN LIQUID EXPLOSIVES.
See Abstr. 7910

SHOCK INITIATION OF SOLID EXPLOSIVES.
See Abstr. 7911

8156 THE THERMAL DIFFUSION FACTOR OF HELIUM. F.van der Valk and A.E.de Vries.
J. chem. Phys. (USA), Vol. 34, No. 1, 345-6 (Jan., 1961).

The thermal diffusion factor of He is found to be constant in the temperature range 370-700°K.
G.I.W.Llewelyn

8157 ERRATUM: THERMAL-DIFFUSION-COLUMN SHAPE FACTORS FOR THE LENNARD-JONES (12-6) POTENTIAL. B.B.McInteer and M.J.Reisfeld.
J. chem. Phys. (USA), Vol. 34, No. 5, 1844 (May, 1961).
See Abstr. 14689 of 1960.

8158 SOUND PROPAGATION IN GASEOUS HYDROGEN. G.Sessler.
Acustica (Internat.), Vol. 10, No. 3, 176-80 (1960). In German.

Sound absorption in normal hydrogen gas was measured at 20° C and at frequency/pressure ratios between 3×10^6 and 1.5×10^8 (c/s)/atm, using an electrostatic transducer with solid dielectric. To explain the measurements, it is assumed that the relaxation times τ_{02} and τ_{13} (belonging to the 0—2 and 1—3 transitions respectively) are in the ratio 2 : 3. Taking two parallel relaxation processes, the results can be fitted to theory if $\tau_{02} = 1.29 \times 10^{-8}$ sec and $\tau_{13} = 1.93 \times 10^{-8}$ sec.

8159 SOUND PROPAGATION IN PARTIALLY DISSOCIATING GASEOUS N_2O_4. G.Sessler.
Acustica (Internat.), Vol. 10, No. 1, 44-59 (1960). In German.

Sound absorption and velocity are calculated under the assumption that the N_2O_4 molecule dissociates as soon as energy is accumulated in certain vibrational degrees of freedom from collisions with other molecules. The accumulation of energy is made in two steps: first, the stored energy reaches an intermediate value E and then it rises to the value of the dissociation energy. The effects of translational, rotational, and those vibrational degrees of freedom, which do not influence the dissociation, on absorption and dispersion are added. In the experimental part of the work electrostatic transducers with solid dielectric were used. These have proved to be very useful for measurements in dissociating gases. Measurements were made at 20° and 53° C, pressures between 1 and 200 mm Hg, and at frequency/pressure values ranging from 10^5 to 10^8 (c/s)/atm. These measurements confirm the theory. It was found that E = = 4.5 kcal/mol at 20° and 53° C. The rate of dissociation constant is proportional to the pressure. Referred to 1 atm and 20° C, this constant is 1.7×10^5 s^{-1} and for 53° C, 8.4×10^5 s^{-1}.

8160 THE PROPAGATION OF SOUND IN NITROUS OXIDE. R.Holmes, H.D.Parbrook and W.Tempest.
Austica (Internat.), Vol. 10, No. 3, 155-9 (1960).

Studied in the range from 100 to 700 kc/s at pressures from 0.025 to 2 atm and at 25° C. The absorption and velocity measurements are consistent with the hypothesis of a single relaxation time (0.96 μs at 1 atm) with binary collisions alone responsible for the transfer of vibrational energy. The measured peak absorption compared well with the calculated value using the vibrational specific heat calculated from spectroscopic measurements. In the region where the visco-thermal and relaxation absorption are of the same order the total absorption is greater than the sum of the relaxation and visco-thermal components.

8161 VIBRATIONAL RELAXATION IN GASEOUS AND LIQUID CHLORINE. E.Sittig.
Acustica (Internat.), Vol. 10, No. 2, 81-6 (1960). In German.

Measurements of sound absorption in the gas in the range 0.1-10 (Mc/s) atm and in the liquid under reduced pressure in the range 1-35 Mc/s at temperatures between 0° and 50° C indicate the existence of a relaxation region. This is ascribed in both cases to a relaxation of the vibrational degree of freedom.

8162 ULTRASONIC RELAXATION IN POLYATOMIC GASES AND VAPOURS. S.K.K.Jatkar and D.D.Deshpande.
Brit. J. appl. Phys., Vol. 12, No. 5, 243-7 (May, 1961).

The paper describes a simple method of calculating ultrasonic relaxation frequencies in polyatomic gases. The mechanism of relaxation is explained as a resonance phenomenon by assuming a

characteristic rotational oscillation frequency of gas molecules in ground state, due to the interaction field of neighbouring molecules. Using infrared vibration and electronic frequencies given by the ionization potential, in the relation $f = (1/2\pi)\sqrt{(3h\nu\alpha^2/4r^6)}$ the relaxation frequencies are evaluated for carbon dioxide, carbon disulphide, nitrous oxide, sulphur dioxide, ammonia, acetaldehyde, benzene, methane and chloromethanes, and are in close agreement with the experimental data. The method is absolute and does not involve calculation of parameters such as partition functions and collision probabilities.

8163 EFFECT OF SEVERAL LIGHT MOLECULES ON THE VIBRATIONAL RELAXATION TIME OF OXYGEN.
J.G.Parker.
J. chem. Phys. (USA), Vol. 34, No. 5, 1763-72 (May, 1961).

Measurements of vibrational relaxation times of O_2–H_2, O_2–D_2, and O_2–He mixtures were carried out by means of an acoustic resonance tube. It was found that all these light elements shorten the vibrational relaxation time of oxygen with H_2 being by far the most effective. Surprisingly, D_2 and He produced almost identical effects, indicating that molecular mass is the dominating factor in the ability of these gases to excite vibration in O_2. Results of these measurements show that an O_2–H_2 collision is 2.96×10^3, an O_2–D_2 collision 2.96×10^2, and an O_2–He collision is 3.53×10^2 more effective than an O_2–O_2 collision. Most extensively studied was O_2–H_2, for which relaxation times were measured in eight different mixtures, the maximum concentration of H_2 being 2.64% and the minimum 0.072%. Variation of the relaxation frequency with H_2 concentration was linear, indicating that binary collisions alone are important. Extrapolation of this data to zero concentration gives a relaxation time for pure O_2 of approximately 1.8×10^{-2} sec which is considerably longer than that obtained by other investigators. Comparison of the experimental data with theory suggests that the variation of intermolecular forces in the interaction of light elements with oxygen is much less steep than one would predict from a knowledge of the interaction forces in the separate similar interactions.

SOUND ABSORPTION MEASUREMENTS USING A CYLINDRICAL RESONATOR. See Abstr. 8186

8164 THE REFRACTIVE INDICES AND VERDET CONSTANTS OF THE INERT GASES. A.Dalgarno and A.E.Kingston.
Proc. Roy. Soc. A (GB), Vol. 259, 424-9 (Dec. 29, 1960).

A method is suggested by which the refractive index and Verdet constant of an atomic system may be derived theoretically. It is applied to atomic hydrogen and to the inert gases and a comparison is made with experimental data. The Verdet constant of neon is not anomalous. The origin of the suggestion appears to be an underestimate of the experimental error. The analysis yields values of the polarizabilities of the inert gases which are respectively He, 1.384; Ne, 2.663; A, 11.080; Kr, 16.734; Xe, 27.292 in units of a_0^3.

8165 SPECTRAL STUDIES OF LUMINESCENCE DUE TO EXCITATION OF INERT GASES BY α-RAYS. L.Koch.
J. Phys. Radium (France), Vol. 21, No. 3, 169-73 (March, 1960). In French.

Luminescence spectra of He, A, Kr and Xe are studied under excitation by α-rays. It is shown that the energy is transferred from excited levels of these gases to Hg and N_2 impurities for impurity concentrations respectively less than 10^{-6} and 10^{-4}. These results confirm previous measurements concerning the period of luminescence and its variations versus nitrogen concentration.

8166 THERMAL CONDUCTIVITY AND EUCKEN-TYPE FACTOR FOR THE BINARY MIXTURES H-He, H-Ne, H-Kr and H-Xe. A.K.Barua.
Indian J. Phys., Vol. 34, No. 4, 169-83 (April, 1960).

In order to test the recent formulae for the thermal conductivity of polyatomic gas mixtures, the thermal conductivities of H_2-He, H_2-Ne, H_2-Kr and H_2-Xe mixtures were measured at 30° and 45° C by using the thick-wire-variant of the hot-wire method. The experimental values of the thermal conductivities of the pure gases and their binary mixtures is lower than those given by Hirschfelder's theory (Abstr. 6096 of 1957) based on the local chemical equilibrium assumption. It is suggested that this discrepancy between theory and experiments at the temperatures under consideration is due to the non-validity of the condition of local chemical equilibrium. Apart from this drawback Hirschfelder's theory is found to represent the concentration dependence of the thermal conductivity of p atomic gas mixtures quite satisfactorily. The more rigorous derived formulae of Hirschfelder is found to represent the th conductivity of gas mixtures better than the approximate equa of Mason and Saxena (Abstr. 1368 of 1959).

8167 ELECTRICAL CONDUCTIVITY IN FLAME GASE LARGE CONCENTRATIONS OF POTASSIUM.
G.J.Mullaney, P.H.Kydd and N.R.Dibelius.
J. appl. Phys. (USA), Vol. 32, No. 4, 668-71 (April, 1961).

The conductivity of the hot gases from propane–oxygen f containing potassium was measured in a coaxial graphite cell the temperature range 1800°-2400° K with potassium concentra of 0.01–1.0% by weight, the measured conductivity agrees wit calculated from the Saha equation and a "free-path" kinetic ec A constant value of 1×10^{-15} cm² was used as the cross-secti collision between electrons and the combustion products in th calculation. At higher potassium concentrations, up to 7½% by the electron–potassium atom cross-section becomes importa a value of about 10^{-15} cm² gives fair agreement with the data. low temperatures and high cell voltages, current saturation r from the limited electron emissivity of the graphite was obse

VACUUM PHYSICS

8168 DIFFUSION PUMPS AND THEIR PHYSICAL AND TECHNICAL DEVELOPMENTS. R.Jaeckel.
Vacuum (GB), Vol. 9, 209-18 (July-Sept., 1959; publ. Dec., 19
In German.

A review of the historical development of the diffusion pu followed by a discussion of the physical principles of its opera The limitation of simplified models is considered followed by review of measurements on diffusion pump jet systems over a of pressure conditions and the factors influencing the ultimate pressure obtainable with these pumps. W.Steckelm

8169 VACUUM GAUGE CALIBRATION SYSTEM (10^{-2} t mm Hg). A.P.Flanick and J.E.Ainsworth.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 408-10 (April, 1961).

Accurately determined pressures can be produced in a va gauge calibration chamber by means of repeated injections of precisely metered masses of air. The apparatus is simple an pressures obtained are highly repeatable.

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

8170 SOME PROPERTIES OF THE CHARACTERISTIC EQUATIONS OF TORSIONAL VIBRATIONS. A.Bal
Acta tech. Hungar., Vol. 32, No. 3-4, 429-40 (1961). In Germa

The relationship between the single power coefficients in t general equations for torsional vibrations is given in matrix fo for a system containing five masses. It is shown how this form readily be applied to a system containing any number of masse H.J.H.S

8171 PEAK CRITERION IN RANDOM VERSUS SINE VIBR TION TESTING. H.R.Spence and H.N.Luhrs.
J. Acoust. Soc. Amer., Vol. 33, No. 5, 652-4 (May, 1961).

Sinusoidal vibration has practical value as a substitute for random vibration in equipment qualification testing. How and w to employ a sinusoidal substitution is discussed. In particular, damage criterion is discussed, which relates the number of sin soidal peaks occurring while passing through a resonance to the number of random test duration to be used with the amplitude relationship.

8172 INVESTIGATIONS ON ORTHOTROPIC SHEETS. M.Heckl.
Acustica (Internat.), Vol. 10, No. 2, 109-15 (1960). In German.

Starting from the equations of Huber (1914) for orthotropic sheets, the flexual wave input impedance, the mean particle velocity and the radiated sound power are calculated for the cas

of excitation at one point. The sound attenuation of infinitely extended sheets is calculated. The expressions derived were checked by measurements on corrugated and slotted sheets.

8173 OSCILLATION MODES OF CYLINDRICAL DISKS OF BARIUM TITANATE CERAMIC.
G.Schmidt and L.Kutschabsky.
Acustica (Internat.), Vol. 10, No. 1, 30-4 (1960). In German.

The axial movement of the surfaces of the disks were investigated, using a capacitance probe, in order to determine the mode of vibration at important resonance positions, in the neighbourhood of the thickness mode. The ratio of diameter to thickness of the probe lay between 4 and 25.9. The method is described and the observed amplitude fields are illustrated. In no case was a resonance with nearly piston-form vibration (as would be expected in an infinite plate) observed.

8174 OSCILLATIONS OF THE ISOTROPIC CIRCULAR CYLINDER WITH A VANISHING AXIAL COMPONENT [OF MOTION]. H.Böhme, E.Fromm and E.Sittig.
Acustica (Internat.), Vol. 10, No. 1, 67-71 (1960). In German.

The resonances of a type of elastic vibration are described. They are characterized by an index consisting of two integral numbers (n, p). The series (n, 1) degenerates with increasing n into surface waves with wave-fronts parallel to the axis. Measurements on glass and aluminium cylinders have confirmed the theoretical results, which may also be used to interpret, in principle, Bergmann's photoelastic pictures.

8175 MODE COUPLING OCCURRING IN THE PROPAGATION OF ELASTIC PULSES IN WIRES. A.H.Meitzler.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 435-45 (April, 1961).

The propagation of elastic pulses in wires of circular cross-section was studied for conditions in which pulses having carrier frequencies ranging from 0.5 to 4.0 Mc/s were transmitted in wires having diameters between 0.1 and 0.2 cm. The pulses used in the experiments were shaped to have relatively narrow frequency spectra. At certain frequencies, herein called critical frequencies, pulses propagating in certain modes were observed to undergo pronounced distortion in which the peak amplitude of an affected pulse was reduced and the duration of the pulse was increased many times its original length. This pulse distortion associated with the presence of critical frequencies is shown to be caused by coupling between two modes of propagation. In agreement with predictions of the general theory of mode coupling, the critical frequencies are frequencies at which two modes of propagation have the same phase velocity.

8176 TRANSMISSION OF PLATE FLEXURAL WAVES THROUGH REINFORCING BEAMS; DYNAMIC STRESS CONCENTRATIONS. E.E.Ungar.
J. Acoust. Soc. Amer., Vol. 33, No. 5, 633-9 (May, 1961).

An infinite plate to which a narrow infinitely long beam is attached rigidly and continuously may be considered as an idealization of some typical flight vehicle structures. Reflection, transmission, and near-field effects, associated with a straight-crested flexural wave impinging on one side of the beam, are presented as functions of the properties of the plate and beam and interpreted in terms of trace matching of the flexural waves in the plate with flexural and torsional waves in the beam. The concepts of dynamic stress and strain concentration factors are discussed, and upper bounds on these factors are given. Some implications pertaining to the design of beam-reinforced panel structures with favourable fatigue properties are pointed out.

ENERGY THEOREM IN MAGNETO-ELASTICITY. See Abstr. 7526

SOME ASPECTS OF ELASTIC WAVE PROPAGATION IN FLUID-SATURATED POROUS SOLIDS. See Abstr. 7925

MULTIPLE SCATTERING OF WAVES BY WEAK RANDOM IRREGULARITIES IN THE MEDIUM. See Abstr. 8242

ACOUSTICS

8177 HYPERSONIC RESONANCE OF QUARTZ AT 3500 Mc. J.L.Stewart and E.S.Stewart.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 538 (April, 1961).

The hypersonic resonance of X cut quartz crystals 0.1 mm thick was observed at room temperature. Six to twelve odd harmonics in the region 2950-3600 Mc/s have been excited in several crystals. Hypersonic radiation into water was detected.

8178 ON THE EDGETONE. A.Powell.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 395-409 (April, 1961).

The feedback mechanism of classical low-speed edgetones in which the action at the edge is interpreted as an acoustical source is developed in detail. A theoretical development indicating that the acoustic field is primarily due to the dipole associated with the fluctuating fluid force on the edge has been verified. It is the hydrodynamic field of the dipole which disturbs the jet, whose instability characteristics are shown to depend acutely on the Reynolds and Strouhal numbers, and the orifice-edge distance. The gain criterion is developed in detail, it being shown how the eigenfrequencies (which can form no algebraic sequence) arise; the lower limit to the orifice-edge distance is discussed, yielding an estimate of the "linear" instability of the stream. The amplitude of the established edgetone depends on the nonlinear behaviour of large-amplitude stream disturbances and the corresponding upper limit to the edge force proves to be in satisfactory agreement with measurements, thus yielding acceptable expressions for the sound pressure. Multiple tones and the circumstances of the hysteretic frequency jumps are discussed. The basic action depends only on Reynolds number for geometrically similar systems, while the sound power depends on the cube of the Mach number also.

8179 FACTORS THAT DETERMINE THE EQUIVALENT NOISE PRESSURE, FREE-FIELD VOLTAGE RESPONSE, AND EFFICIENCY OF A TRANSDUCER AT LOW FREQUENCIES. P.M.Kendig.
J. Acoust. Soc. Amer., Vol. 33, No. 5, 674-6 (May, 1961).

The physical properties and dimensions that determine the equivalent noise pressures of several different shapes of piezoelectric transducers are examined. Expressions for the equivalent noise pressure, free-field voltage response, and electroacoustical efficiency at low frequencies — those frequencies for which the free-field voltage response is flat — are obtained in terms of generally known or easily measured parameters. The results indicate that at low frequencies a well designed hydrophone should have an equivalent noise pressure well below zero sea-state ambient. It is emphasized that the free-field voltage response is not an indication of the ability of a hydrophone to measure low-level signals, but that either the efficiency or the equivalent noise pressure is an essential indication of this ability.

8180 ULTRASONIC TRANSMISSION AT BOUNDARY SURFACES. R.Pohlman.
Acustica (Internat.), Vol. 10, No. 4, 217-29 (1960). In German.

An integration probe, suitable for technological measurements was constructed and, on the principle of the diminished pressure caused by disturbances of the stationary wave pattern was used with precision in enclosures not completely anechoic. It appears that making the walls $n\lambda/2$ thick is less efficient than the transmission by waves in plates. The precision of both methods is discussed, and a system involving the second is described. Reflection coefficients dependent on intensity were found in buna-rubber and teflon sheets.

8181 LONG-RANGE SOUND PROPAGATION IN THE DEEP OCEAN. F.E.Hale.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 456-64 (April, 1961).

The high intensity and low distortion of underwater acoustic signals propagated to convergence zones justifies a comprehensive description and an effort toward better organization of pertinent and related information. Convergence zones are the result of SOFAR Channel propagation from shallow sources to shallow receivers. The acoustic paths are analogues to those of skip-wave radio transmission. Although only illusive references exist in the open literature, there have been experiments showing as many as thirteen well-formed zones spaced over a 400 mile range interval. The propagation is quantitatively predictable and quite stable. Convergence of acoustic energy along caustics results in losses smaller by about 20 dB than those encountered in a free field.

MOIRE FRINGE ANALOGS IN UNDERWATER
8182 ACOUSTICS. D.E.Weston.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 540 (April, 1961).

For previous work see Abstr. 10718 of 1960. Attention is given to the work of Pohl (1943) and Shubnikov (1960) with moiré patterns from circular grids which are of possible use in underwater array design and underwater sound propagation investigations.

SPECTROSCOPIC INVESTIGATION OF THE PROPA-
8183 GATION OF HYPERSONIC VIBRATIONS IN VISCOUS LIQUIDS. M.S.Pesin and I.L.Fabelinskii.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1114-16 (Dec. 11, 1960). In Russian.

The velocity of propagation of hypersound in triacetin (in the temperature range from +72 to -60°C, when it passes from a liquid into a vitreous solid) and some new properties of glycerine at -70°C were determined using an interference apparatus described by Velichkina [Trudy Fizicheskogo Instituta imeni P.N. Lebedeva Akademii Nauk SSSR, Vol. 9, 59 (1958)]. The velocity of hypersound was determined with an accuracy of 6-8%. Throughout the whole temperature range the fine structure of the Rayleigh line was distinctly visible. The agreement between theory and experiment in the case of hypersound is somewhat better than for the ultrasonic range. [English translation in: Soviet Physics—Doklady (USA)].

F.Lachman

SOUND PROPAGATION IN A FIBRE BLOCK AS A
8184 COMPOSITE MEDIUM. Y.Kawasima.
Acustica (Internat.), Vol. 10, No. 4, 208-17 (1960).

The sound absorbing properties of a fibre block are treated with a composite medium model, in which the fibres are suspended in the air under certain binding forces. The sound absorption is considered to be caused by the frictional losses arising from the relative velocities and by the heat conduction between the air and the fibres. Usually the latter effect is found to be small compared with the former. The dependence, in a microscopic sense, of the acoustic characteristics on the geometrical structure and on the physical characteristics of the fibre block are derived theoretically.

SOUND ATTENUATION AND AMPLIFICATION IN AIR
8185 FLOW THROUGH DUCTS WITH ABSORBENT LININGS. F.Mechel.
Acustica (Internat.), Vol. 10, No. 3, 133-48 (1960). In German.

Using a simple equation the possible influences of flow on the attenuation of airborne sound in flow ducts are discussed. Measurements with porous absorbers show changes of the attenuation caused by the flow, which correspond to the change of wavelength in the duct, and non-reciprocity of the attenuation. With absorbers consisting of damped Helmholtz resonators, the resonance attenuation is reduced by nonlinearities in the resonator necks. "Pseudo-sound" in flow and partial waves in ducts with a periodic structure of the boundaries are used for the explanation of signal amplification at reactive absorbers in the flow. The explanation is made in close analogy to the description of the travelling-wave tube amplification mechanism. The theory is confirmed by measurements with resonance absorbers.

PRECISION MEASUREMENT OF THE CLASSICAL
8186 SOUND ABSORPTION WITH THE HELP OF THE CYLINDRICAL RESONATOR. I. L.Fritsche.
Acustica (Internat.), Vol. 10, No. 4, 189-98 (1960). In German.

An arrangement for the accurate measurement of the sound absorption in gases with the help of resonances inside a cylindrically shaped vessel is described. Measurements of the classical wall and volume effects of the sound absorption in argon, nitrogen and water vapour in the frequency/pressure range 10^3 to 10^6 (c/s)/atm show good agreement with Kirchhoff's theory, if sound excitation and rigid closure of the vessel at all sides are properly taken into consideration. In contrast to many former measurements, those reported here confirm Kirchhoff's theory and form a dependable basis for the determination of the "super-classical" sound absorption.

THEORY OF THE ACOUSTIC CYLINDRICAL
8187 RESONATOR TAKING THE EXCITATION OF SOUND INTO ACCOUNT. II. L.Fritsche.
Acustica (Internat.), Vol. 10, No. 4, 199-207 (1960). In German.

From the laws of conservation of fluid mechanics and the equation of state of ideal gases, an approximate solution of the boundary value problem for a closed, gas-filled cylindrical resonator is deduced considering the excitation of the sound. The quality of this approximation agrees with the requirements generally given by the order of magnitude of experimental error (> 1%). Infinite thermal inertia and rigid walls, as well as infinitely small sound amplitudes, are prerequisites of the theory. Of the transportation phenom only heat conduction and friction are taken into account. Rela processes is gases are not taken into consideration. The line extension of the theory to such processes is possible without culties by the introduction of a time dependent dynamic equati state. The theory is in very good agreement with the experim results already reported (see preceding abstract).

THE NATURAL FREQUENCIES OF MUSICAL HOR
8188 F.J.Young.
Acustica (Internat.), Vol. 10, No. 2, 91-7 (1960).

A general method for the precise calculation of the natura frequencies of horns having any cross-sectional area versus l characteristics is devised. The new method is applied to the flügelhorn and the tenor trombone. The results are critically examined with respect to various musical scales and the role the internal impedance of the musician is discussed. Means b which the intonation of horns might be improved are presentec

PIANO SOUNDING-BOARD VIBRATION.
8189 B.F.Miessner.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 539-40 (April, 1961).

Experiments with maintained, single-plane, fundamental vibrations of piano strings, to determine the spectral content the soundboard radiation for variations of that plane's angle fr normal to the bridge and sound board.

MODEL EXPERIMENTS ON ELECTROMAGNETIC
8190 REFLECTED BEAM DIRECTION FINDING (RADA USING ULTRASONIC WAVES (SONAR). E.Meyer and P.Schnu
Acustica (Internat.), Vol. 10, No. 1, 1-13 (1960). In German.

The following results were obtained from model experime for radar camouflage using ultrasonic waves (sonar) of 2.5 mm wavelength: The radar screen picture is essentially composed signals reflected optically from plane surfaces and of scatter s from edges. The level of the scatter signals from edges was a least 30 dB below that of the optical reflections. The scattere wave from an edge is only slightly changed when the adjoining face is covered with absorbers. In order to lower the level of scatter signals from edges by about 10 to 20 dB down to the no level it is sufficient to tooth the edges over a distance equal to several wavelengths. Screen pictures of model villages are gi Measurements of the back scattering of spheres, cylinders and circular disks of various cross-sectional area were used for c rating the apparatus.

LIGHT DIFFRACTION BY PROGRESSIVE ULTRASONIC W IN PLEXIGLAS. See Abstr. 8237

Instruments and Measurements

A NEW REVERBERATION ROOM FOR SOUND
8191 WAVES AND ELECTROMAGNETIC WAVES.
E.Meyer, G.Kurtze, H.Kuttruff and K.Tamm.
Acustica (Internat.), Vol. 10, 253-64 (1960). = Akust. Beihefte, N (1960)]. In German.

The new reverberation room of the III Physikalisches Inst University of Gottingen, has a volume of 342 m^3. This room is reverberant for acoustical waves as well as for electromagneti waves. The acoustical reverberation time of the room is 33 s 100 c/s and 13 s at 1000 c/s. In order to obtain a high degree diffusity 24 scattering objects — bent Plexiglas plates with 2 m^2 surface — are suspended in the room. Parallel walls are avoide small deviations from the square shape. The expediency of thes measures was proved in a number of preliminary model experi It was tried to obtain a high degree of sound insulation by using double walls; for the same reason the inner structure of the roo is supported on steel springs. The sound insulation thus attaine is about 80 dB. The entire surface of the room is coated with copper foil. The reverberation time for electromagnetic waves 400 μs at 10 kMc/s corresponding to a quality of 1.7×10^6. No scattering objects are used in this case.

THE CONSTRUCTION OF AN ANECHOIC ACOUSTI
8192 WATER BASIN. E.Meyer, W.Schilz and K.Tamm.
Acustica (Internat.), Vol. 10, 281-7 (1960) [=Akust. Beihefte, No. (1960)]. In German.

A water basin with the dimensions $7 \times 4 \times 4$ m was constru for measurements with water-borne sound. The walls of this ba are coated with absorbers effective in the frequency range from

5 to 70 kc/s. These broad-band absorbers consist of a system of parallel, wedge-shaped rubber plates made up of three layers of rubber glued together. The centre sheet is perforated with circular holes (diameter 4 mm, hole density 4%). There are three types of wedge differing in length (7, 15 and 20 cm) and covering the frequency range from 5 to 70 kc/s. The reflection factor related to amplitude remains below 10% in this frequency range. The excellent acoustical properties of the anechoic measuring basin are confirmed by the very small standing-wave ratio for all frequencies.

8193 THE USE OF RADIALLY GRADED ULTRASONIC RADIATORS TO IMPROVE THE UNIFORMITY OF THE NEAR FIELD. G.Bradfield.
Medical Electronics Conference, Paris, 1959 (see Abstr. 14326 of 1960) p. 367-72.

The characteristics of the radiation fields of ultrasonic therapeutic and surgical radiators are examined. It is pointed out, in connection with the former, that the intensity varies upwards to four times the mean value and downwards to zero. This unevenness is only partially smoothed by the usual prove movements. It is possible to provide transducers with much reduced non-uniformity of field and the design and performance of these are discussed. The danger of radiation in unwanted directions from surgical radiators is considered and a design in which such radiation is reduced is described.

8194 DESCRIPTIONS AND RESULTS OF INVESTIGATIONS OF AN ELECTRONIC ULTRASONIC IMAGE CONVERTER. W.Freitag, H.J.Martin and G.Schellbach.
Medical Electronics Conference, Paris, 1959 (See Abstr. 14326 of 1960) p. 373-9.

This description deals with a supersonic image convertor which, because of its electronic mode of operation, operates with a picture-frequency of 50 c/s without inertia, and has a relatively high sensitivity, which makes it specially useful in medico-diagnostic examinations. The results obtained with this image convertor are demonstrated.

8195 ULTRASONIC IMAGE CONVERSION USING AN ELECTRON MIRROR. G.Koch.
Acustica (Internat.), Vol. 10, No. 3, 167-70 (1960). In German.

A description of an ultrasonic image-converter operating on the basis of electron reflection, and, the results achieved with it. The contrast of the image is greatest with a moving object. The distortions remain within reasonable limits.

8196 A MICROPHONE ARRANGEMENT WITH LARGE DIRECTIONAL RESPONSE. P.Dämmig.
Acustica (Internat.), Vol. 10, No. 2, 120-3 (1960). In German.

An arrangement is described consisting of two cross-wise connected linear groups of tubular directional microphones. The half-width of the directional pattern corresponds to about 15° at 1 kc/s and 12°at 4kc/s.

8197 ABSOLUTE DETERMINATION OF THE RESPONSE CHARACTERISTIC OF MICROPHONES IN THE DIFFUSE SOUND FIELD. H.G.Diestel.
Acustica (Internat.), Vol. 10, 277-80 (1960). [= Akust. Beihefte, No. 1 (1960)]. In German.

With the aid of Schottky's relationship between the action of a transducer as a microphone and as a loudspeaker in free space, it is possible to deduce the reciprocity parameter for the diffuse sound field of a chamber, with volume V and reverberation time T, as $J_d \cong (2.1/\rho_o f)(V/cT)^{1/2}$ where f = frequency, ρ_o = mean air density, c = sound velocity. Knowing the reciprocity parameter, it is possible to derive the absolute diffuse-field response of a microphone from electrical measurements in the chamber. The apparatus for doing this is described and, as an example, the diffuse-field calibration curve of a condenser microphone in the range from 500 to 16 000 c/s is given.

8198 COMPARISON ANALYSIS ON FOUR DIRECTIONAL RECEIVER CORRELATORS.
M.J.Jacobson and R.J.Talham.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 518-26 (April, 1961).

Four correlation systems are studied which make use of two pressure-gradient receivers having first-order cosine directional characteristics. The systems differ in the methods of steering both the receivers and the receiver baseline. The steering may be accomplished by rotation or by the insertion of appropriate time delays. The mean, variance, and output signal to noise ratio are computed for each system when a distant localized signal source is present in both circular and spherical noise fields. In addition, the directive properties of the mean outputs are examined. For a signal with rectangular power spectrum, the main lobe widths of the mean outputs are found, the behaviour of the means in the neighbourhood of source direction is examined, and an investigation is made of the mean output level for steering directions removed from source direction.

8199 OSCILLATORY PROPERTIES OF SELL-TYPE ELECTROSTATIC TRANSDUCERS. K.Geide.
Acustica (Internat.), Vol. 10, 295-304 (1960). [=Akust. Beihefte, No. 1 (1960)]. In German.

Amplitude and phase of the vibration of the membrane were studied point-for-point with a capacitive probe. From the results a number of mean or extreme values characterizing the behaviour of the membrane are derived. These values are compared with respect to their dependence on air pressure, membrane material, surface properties of the back plate, and excitation voltage; optimal values for various applications are found.

8200 TRANSIENTS AND THE EQUIVALENT ELECTRICAL CIRCUIT OF THE PIEZOELECTRIC TRANSDUCER. L.Filipczynski.
Acustica (Internat.), Vol. 10, No. 3, 149-54 (1960).

One-dimensional mechanical vibrations in an X-cut quartz transducer are discussed. Starting with the piezoelectric equations in terms of the electrical enthalpy, the transients of the transducer, frequency-response characteristics and the input impedance are analysed. Experimental results confirm the proposed mechanism of the vibrations, as well as the frequency-response characteristics. On the basis of the results obtained, an equivalent electrical circuit of the transducer is constructed in terms of a transmission line. This circuit is valid for both steady and for transient states.

8201 TRANSIENT PERFORMANCE OF A PIEZOELECTRIC TRANSDUCER. M.Redwood.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 527-36 (April, 1961).

The methods of transform calculus are used to solve several problems in which the transient response of a piezoelectric transducer is of interest. The electrical signal produced by a step function of force is derived, both for open-circuit and resistive loading at the electrical terminals, and the mechanical signal produced by a voltage step is also discussed. The analyses are performed for both the plate transducer in compressional thickness vibration and the bar in compressional length vibration, and the important differences between the two transducers are discussed. The analyses commence with the fundamental piezoelectric equations, and solutions are found which represent successive time-delayed reflections of the mechanical transient between the end faces of the transducer. The results are also discussed with reference to the exact transmission-line electrical equivalent circuits of the transducers, whose development is outlined briefly. Simple equivalent circuits which do not involve lines are described; these make it possible to determine many features of the transient without resource to the full theoretical analysis.

LOUDNESS AND LOUDNESS LEVEL. See Abstr. 7962

Noise . Architectural Acoustics

8202 THE LOUDNESS OF DIRECTIONAL SOUND FIELDS. D.W.Robinson and L.S.Whittle.
Acustica (Internat.), Vol. 10, No. 2, 74-80 (1960).

The loudness of progressive sound waves was investigated subjectively as a function of the orientation of the source at frequencies in the range from 1600 c/s to 10 kc/s, and extending over the three principal planes referred to the listener. Simultaneously, measurements of sound pressure were made at the ears of the listeners, which provide a satisfactory interpretation of the subjective results. It is concluded that loudness is determined solely by the sound pressures at the left and right ears if binaural summation in accordance with approximately the "6 dB law" is assumed. The results are intended as corrections to existing equal loudness relations for normally-incident sound waves. An extension to diffuse fields is still in progress.

8203 A METHOD FOR CALCULATING LOUDNESS. E.Zwicker.
Acustica (Internat.), Vol. 10, 304-8 (1960). [=Akust. Beihefte, No. 1 (1960)]. In German.

A simplified graphical method is described for the calculation of loudness levels from third octave band level diagrams measured in free or diffuse sound field.

8204 SOUND REINFORCEMENT AT THE SIDNEY MYER MUSIC BOWL, MELBOURNE, AUSTRALIA. R.W.Muncey and A.F.B.Nickson.
Acustica (Internat.), Vol. 10, No. 1, 60-6 (1960).

This is an outdoor auditorium for speech, music and drama. It is unique in that the main structure or "canopy" covers both the stage and 2000 fixed seats, an area about one eighth of the bowl proper. The ground under the canopy was excavated to depths of up to 10 m and this allows an audience of 30 000 to view the entire stage. Overflow audiences of two or three times this number can listen in areas out of sight of the stage. The paper describes the sound reinforcement system and some measurements of reverberation time, transmission characteristics, pulse response and insulation from unwanted noise. Subjective impressions as reported of music critics and others are included.

8205 ORCHESTRA ENCLOSURE AND CANOPY FOR THE TANGLEWOOD MUSIC SHED. F.R.Johnson, L.L.Beranek, R.B.Newman, R.H.Bolt and D.L.Klepper.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 475-81 (April, 1961).

This large fan shaped hall seating 6000 people indoors (approximately 6000 more can be accommodated outdoors on the lawn) was modified in 1959 to improve the acoustics. The acoustical qualities that were to be improved included sectional balance for large orchestra, balance between orchestra and soloist, clarity of music inside the hall, and loudness of music on the lawn. The architectural solution was the design of an orchestra enclosure and a canopy over the orchestra and the front part of the audience. Also, a 14 ft high chamber music orchestra enclosure was installed in 1960. Details of the construction are discussed and comments made by musicians and listeners following its completion are given.

8206 THE SOUND DAMPING OF HOMOGENEOUS PLAIN WALLS WITH ENCLOSED SURFACES. M.Heckl.
Acustica (Internat.), Vol. 10, No. 2, 98-108 (1960). In German.

The sound insulation of partition walls with vertically adjacent side walls is calculated. The calculation reveals that there is a marked influence of the side walls — i.e. of the boundary conditions — on the sound insulation, especially above the coincidence frequency. Only if less energy is transmitted into the side walls than is absorbed by internal friction, the insulation is independent of the wall and of its boundary conditions.

8207 THE EFFECT OF SOUND SCATTERING ON SPHERICAL AND CYLINDRICAL SEGMENTS AT REVERBERATION CHAMBER WALLS. G.Venzke.
Acustica (Internat.), Vol. 10, No. 3, 170-2 (1960). In German.

The sound-scattering properties of segments of spheres and cylinders were investigated in a reverberation chamber of 250 m^3 volume by means of absorption coefficient measurements. Besides the shape and number of scattering elements, the size of the absorbing surface and its position relative to the diffusors were varied.

8208 INTERLINKED MECHANICAL IMPEDANCES IN THE MEASUREMENT OF STRUCTURE-BORNE SOUND DAMPING AT CORNERS AND AT UNIFORM JOINTS MODEL EXPERIMENTS. H.Hinsch.
Acustica (Internat.), Vol. 10, 287-94 (1960). [Akust. Beihefte, No. 1, (1960)]. In German.

The sound damping at joints in buildings has been determined so far from the difference of the particle velocity of bending waves in front of and behind such joints. This difference depends, however, on the direction of sound transmission, if the walls and ceilings forming a joint have different properties. The interlinked impedance is found to be the appropriate value for the characterization of the sound damping; as a consequence of the condition of reciprocity the interlinked impedance is independent of the direction of transmission. For simple models of bars, a theory is derived for the calculation of the interlinked impedance. Measurements were made with a number of such models in order to check this theory. It is shown, with a number of examples, that it is possible to apply this theory to joints in buildings. Therefore, there is a possibility of determining sound damping of joints without making actual measurements.

8209 THE MEAN FREE PATH IN ROOM ACOUSTICS. C.W.Kosten.
Acustica (Internat.), Vol. 10, No. 4, 245-50 (1960).

The mean free path of an enclosure — which is of practical us in diffuse sound fields — is shown to be four times the ratio of volume over surface (4V/S). This holds, without any approximatio for all room shapes. In the rather extensive literature on this important quantity, a straightforward and simple derivation could not be found. Discrepancies from 4V/S, reported in literature, are discussed and explained.

8210 EFFECT OF EDGES ON THE SOUND ABSORPTION OF PORONS MATERIALS. von W.Kuhl.
Acustica (Internat.), Vol. 10, 264-76 (1960) [= Akust. Beihefte, No. (1960)]. In German.

A survey is made of various theoretical investigations concerr ing increase of the absorption of sound due to diffraction at edges. Measurements of sound absorption of rock wool plates are reporte and compared with calculations and measurements of other authors With constant over-all surface area the size of single sections and thus also the edge length, was varied over wide range. The absorp tion coefficient increased, from the lower limiting value (without diffraction), proportionally to the normalized edge length. For small surface areas an upper limiting value is reached, which for high impedance is eight times the relative conductance. Plotting th absorption coefficient versus edge length, it is seen that the shape of the resulting curve is the same for all measurements and calcul tions. The absorption coefficient is essentially increased, if small samples are placed in the corners or edges of the room. The edge effect is reduced if the edges of the absorbing sheets are lines with broad planks or if the material is tesselated.

8211 MEASUREMENT OF THE SOUND INSULATION BY RANDOM AND BY NORMAL INCIDENCE OF SOUND. E.Brosio.
Acustica (Internat.), Vol. 10, No. 3, 173-5 (1960).

A comparison is made of experimental data of transmission loss measured by random and by normal incidence of sound. The London (1940) theory is found to agree well with these data: for given partitions it is then possible to calculate one of the two values when the other has been determined experimentally.

OPTICS . PHOTOMETRY

8212 HISTORY OF THE PHOTOMETRIC QUANTITIES AND SOME PROBLEMS CONNECTED WITH THEM. D.Hahn and U.Schley.
Lichttechnik (Germany), Vol. 13, No. 2, 58-63 (Feb., 1961). In German.

Traces the development of the system of photometric quantities and units, with particular reference to the standard of luminous intensity. The evolution of the present standard, side by side with the development of radiation theory, is shown in a full-page table, with dates. The effects on the standard of uncertainties in the radiation constants and in the values of the relative luminous efficiency of radiation are discussed. The advantages of a standard operating at the Ir point (2716°K) instead of the Pt point are great and work on such a standard is in progress in Germany.

J.W.T.Walsh

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

8213 RAY-TRACING THROUGH A LENS SYSTEM BY MEANS OF LINE COORDINATES. F.Franke.
Jenaer Jahrbuch (Germany), 1960 I, 34-47. In German.

The method applies to spherical surfaces only. An incident ray is defined by its line coordinates and the point of incidence P is found from the fact that the polar planes with respect to the sphere of all points on the ray form a plane pencil containing the tangent plane at P. Formulae similar to those in the usual algebraic ray-tracing schemes are obtained. W.T.Welford

8214 QUANTITATIVE MEASUREMENT OF ABERRATION BY RONCHI TEST. I.Adachi.
Alti Fond. Ronchi (Italy), Vol. 15, No. 6, 550-85 (Nov.-Dec., 1960).

Continuation. See Abstr. 1807 of 1961.

8215 OPTICAL ABERRATION COEFFICIENTS. IX. THEORY OF REVERSIBLE OPTICAL SYSTEMS. H.A.Buchdahl.
J. Opt. Soc. Amer., Vol. 51, No. 6, 608-16 (June, 1961).

For Pt VIII see Abstr. 10751 of 1960. It is shown that if such a system is not working at unit magnification ($m^2 \neq 1$), then not all of its aberrations can be removed simultaneously. In particular it is shown that if s is the magnification associated with the pupil planes, f the focal length, $\sigma_1, \sigma_2, \cdots, \sigma_5$ the primary (Seidel) coefficients, then

$$(1 - s^2)(1 - sm)\sigma_1 + [3(1 - sm)^2 - (s - m)^2]\sigma_2 + \\ + (1 - m^2)(1 - sm)(3\sigma_3 + \sigma_4) + (1 - m^2)^2\sigma_5 = -\tfrac{1}{2}(1 - m^2)/f^2.$$

The variables entering into the aberrations here are the ideal image height and polar coordinates in the plane of the exit pupil. Analogous relations hold between coefficients of higher order, and some of them are derived explicitly. The number of relations in any order is counted. The usual results concerning systems working at unit magnification are derived, and the special case m = 0 (object at infinity) is discussed separately. The third- and fifth-order relations are transcribed (in the case m = 0) into the language of the "algebraic" coefficients which have been investigated in previous papers of this series and elsewhere. Finally, the problem of the imaging of plane objects is examined in some detail both when $m \neq 0$ and when m = 0; and it is shown that when $m^2 \neq 1$ a sharp image can be formed only on an ellipsoid or hyperboloid of revolution unless m = 0. In the latter case one is of course left with a large amount of distortion when the image is plane.

8216 USE OF HEAT FILTERS AND COLD MIRRORS IN PROJECTORS. W.Naundorf.
Jenaer Jahrbuch (Germany), 1959 II, 290-9. In German.

The gains in efficiency for visible light are computed for sources of colour temperatures 3100 and 4800° K. W.T.Welford

8217 THE LIGHT TRANSMISSION AND TEMPERATURE RELATIONSHIP IN PROJECTION SYSTEMS USING HEAT ABSORBING FILTERS. E.Helbig.
Jenaer Jahrbuch (Germany), 1960 I, 66-77. In German.

The general method for calculating light transmission, heat absorption and temperature rise of a filter is given. Typical projection systems, using heat absorbing filters are described and the transmissions for a given maximum temperature rise are calculated. The properties of a number of commercially available filter materials are shown in graphical form. R.W.Fish

8218 METHODS FOR THE EXACT CALCULATION OF THE LIGHT TRANSMISSION OF [FILM] PROJECTION SYSTEMS. R.Tiedeken.
Jenaer Jahrbuch (Germany), 1959 I, 44-54. In German.

Theoretical. Integrals over films and pupil surfaces are given for the screen illumination. W.T.Welford

DETERMINATION OF THE PRINCIPAL REFRACTIVE INDICES OF CRYSTAL FRAGMENTS. See Abstr. 7855-6

8219 THE ULTRA-VIOLET FLYING SPOT TELEVISION MICROSCOPE. P.O'B.Montgomery and W.A.Bonner.
Medical Electronics Conference, Paris, 1959 (see Abstr. 14326 of 1960) p. 488-92.

Extensions of the basic ultraviolet television microscope technique now permit a variety of experimental living cell research problems to be attacked. It is now possible to produce a focal beam of intense ultraviolet irradiation of any size down to 1 μ. This focal area of irradiation can be visually adjusted in size, shape and position to fit any component area of the living cell. Ultraviolet absorbing areas not being subjected to this intense irradiation may then be visualized by additional ultraviolet light, or the non-irradiated areas may be illuminated entirely by visible light. Alternatively, one may present simultaneously on each half of one monitor screen two images of one specimen. One image is an ultraviolet absorption image, while the other is a visible-light image. This simultaneous presentation of the same specimen on one monitor tube in two wavelengths of light permits one to evaluate instantly the absorption image in comparison with the non-absorption image.

8220 AN OPTICAL "SOLID-IMAGE" MICROSCOPE. R.L.Gregory.
Medical Electronics Conference, Paris, 1959 (see Abstr. 14326 of 1960) p. 591-5.

This microscope differs from the usual stereoscopic microscope in that the "solid" image occupies a block of space. It is possible to view the image from different positions. As the viewing position is changed, the structures change their relative positions. The method is to scan the focal plane of the objective lens through the specimen, at a rate above the fusion frequency of the eye, and to project this upon a vibrating screen. The structure in depth is thus scanned, and represented in three-dimensional space in the volume swept by the vibrating screen.

8221 FOCAL AND EXTRA-FOCAL MICROSCOPE IMAGE FORMATION OF A SINGLE DIMENSIONED OBJECT. H.Stephani.
Jenaer Jahrbuch (Germany), 1959 II, 271-89. In German.

Formulae are given for the intensity distribution in the image of a thin, single dimensioned object of arbitrary phase and amplitude characteristics. The formulae are compared with earlier results, and are applied to a number of special cases. Extension of the formulae to phase contrast work is described. R.W.Fish

8222 ADDITIONS TO THE WORKS OF ABBE. I. H.Boegehold.
Jenaer Jahrbuch (Germany), 1960 I, 12-33. In German.

Nine short papers originally published in English in the Journal of the Royal Microscopical Society between 1881 and 1886 are reproduced translated into German. The titles are: "The origin of homogeneous immersion"; "Notes on aperture, microscopical vision and the value of wide-angle immersion objectives"; "Perception of depth in the microscope"; "Miniatured images"; "On the estimation of aperture in the microscope"; "The future of the microscope"; "Eyepiece magnification"; "The limits of resolution in the microscope"; "Changing eyepieces without altering focus". W.T.Welford

8223 LIGHT MODULATION AND IMAGE PRODUCTION BY MEANS OF ELECTRO-OPTICAL CRYSTALS. S.Rissmann and H.Vosahlo.
Jenaer Jahrbuch (Germany), 1960 I, 228-44. In German.

The phenomenological theory of the electro-optical effect is given and practical arrangements using ADP and KDP in Kerr cells described. The theory is given of a proposed method of image production in which a modulated electron beam is scanned over a crystal and the modulation is reproduced as a light image by means of the electro-optical effect. Some preliminary experiments gave positive results. W.T.Welford

NEW PHOTOELECTRIC APPARATUS FOR THE INVESTIGATION OF FLUORESCENCE POLARIZATION. See Abstr. 8128

MEASUREMENT OF STRESS AND STRAIN BIREFRINGENCE IN SOLID POLYMERS. See Abstr. 7703

8224 CYLINDRICAL DIELECTRIC WAVEGUIDE MODES. E.Snitzer.
J. Opt. Soc. Amer., Vol. 51, No. 5, 491-8 (May, 1961).

The propagation of cylindrical dielectric waveguide modes near cutoff and far from cutoff are considered. The relative amounts of E_z and H_z, and the transverse components of the field are determined for both sets of hybrid modes. With the radial dependence of the z components of the field in the central dielectric given by $J_n(ur/a)$, the transverse components far from cutoff are given by $J_{n\pm1}(ur/a)$, where U is a parameter found from the boundary conditions and which fixes ths scale of the Bessel function relative to the boundary r = a. The two values n + 1 and n−1 correspond to the two sets of modes. The designations of the hybrid modes are discussed. Field plots for the lower order modes are given.

8225 OBSERVED DIELECTRIC WAVEGUIDE MODES IN THE VISIBLE SPECTRUM. E.Snitzer and H.Osterberg.
J. Opt. Soc. Amer., Vol. 51, No. 5, 499-505 (May, 1961).

The direct images and the radiation patterns of the first few lowest-order dielectric waveguide modes were observed in the visible region of the spectrum for fibres with core and cladding indexes of refraction of 1.56 and 1.52, respectively, and for core diameters from 0.1 to 5.5 μ. The cut-off wavelengths for the observed modes are in reasonably good agreement with theory. Photographs of the modes are shown.

8226 FIBER OPTICS DUODENOSCOPE AND URETERSCOPE. J.H.Hett and L.E.Curtiss.
J. Opt. Soc. Amer., Vol. 51, No. 5, 581-2 (May, 1961).

Glass-on-glass fibre bundles were made with a resolution of better than 20 optical lines per millimetre in a 36 in. length. Transmittance is 47% in the range 5600-7000 A. Bundles ¼ in. in diameter were incorporated in a duodenoscope, permitting the examination of the duodenum. A ureterscope 3½ mm in diameter and 30 in. long was also constructed for the examination of the ureter and kidney.

8227 MEASUREMENT OF NANOSECOND SCINTILLATION DECAY TIMES. H.Dreeskamp, A.K.Ghosh and M.Burton.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 304-7 (March, 1961).

An experimental method for measuring scintillation decay times of the order of nanoseconds is described. The method involves a repetitive time selection technique; i.e., in a sense, it is the electronic equivalent of the original Becquerel phosphoroscope. The complete circuitry is shown and some illustrative results are given.

8228 RAPID-SCAN SPECTROSCOPY WITH A FABRY–PEROT INTERFEROMETER. R.W.Terhune and C.W.Peters.
J. Opt. Soc. Amer., Vol. 51, No. 5, 530-4 (May, 1961).

The construction and operation of a variable spacing Fabry–Perot interferometer that could be used at scanning rates up to 500 scans/sec is described. Multilayer interference coatings were used for reflecting surfaces in the near infrared. The high spectral luminosity of the interferometer made its use favourable in low orders for rapid-scan spectroscopy, and in high orders in combination with a grating spectrometer for greater spectral resolution.

COMPARATIVE RESULTS OF PHOTOELECTRIC PHOTOMETRY AND PHOTOGRAPHIC SPECTROPHOTOMETRY.
See Abstr. 7972

8229 HIGH-RESOLUTION GRATING MONOCHROMATOR FOR SIMULTANEOUS OBSERVATIONS OF MORE THAN ONE WAVELENGTH. H.H.Stroke and K.K.Y.Li.
J. Opt. Soc. Amer., Vol. 51, No. 6, 678-80 (June, 1961).

The use of added camera mirrors in a high-dispersion grating monochromator to extend its application to the simultaneous observation of two (or several) wavelengths without diminution of aperture, and with arbitrary separation of the lines on the plate, is described.

8230 DIGITAL CIRCUIT FOR MEASUREMENT OF SPECTRAL LINE INTENSITIES.
S.Minami, H.Yoshinaga and S.Fujita.
J. Opt. Soc. Amer., Vol. 51, No. 6, 674-8 (June, 1961).

A circuit for measurement of the integrated d.c. signal from a photosensitive device was constructed. The principal part is an analogue-to-digital converter using a step integrator. With the auxiliary circuit added, the converter has nonlinear characteristics, which linearizes a nonlinear input. The long-term lack of reproducibility of the analogue-to-digital conversion is less than ±0.1% of the full-scale count. The nonlinear analogue-to-digital conversion system, makes possible a direct readout of the element concentration in the emission spectrochemical analysis.

8231 AN INFRARED GAS MICROCELL. G.R.Bird.
J. Opt. Soc. Amer., Vol. 51, No. 5, 579-80 (May, 1961).

A simple microcell was developed for infrared spectroscopy of gases. This cell is based on the light-pipe principle, and employs no curved optical surfaces. A cell with path length of 7.5 cm and internal volume 1.0 cm^3 was constructed, and made to give transmittances of about 50% throughout the 2-15 μ region of the infrared spectrum. Methods for further reduction of sample volume are discussed. This cell should be useful for examination of impurity components from gas chromatography samples.

8232 MILLIMICROSECOND LIGHT SOURCE WITH INCREASED BRIGHTNESS. H.Fischer.
J. Opt. Soc. Amer., Vol. 51, No. 5, 543-7 (May, 1961).

Short light pulses with $\sim < 2 \times 10^{-9}$ sec rise time and $\sim < 8 \times 10^{-9}$ sec half-width are obtained in a coaxial capacitor discharge in air of minimum inductance, $\sim < 1 \times 10^{-8}$ henry; capacitor energies are in the order of 10^{-2} joule. The current density in the arc channel, ~ 0.1 mm in diameter, exceeds 10^7 A/cm^2; arc channel appear to be pinched. A brightness of $> 10^7$ candles/cm^2 is determined and the method of measurement described. Single-shot photography is shown.

8233 A THEORY OF THE FILAMENT TEMPERATURE DISTRIBUTION OF THE TUNGSTEN VACUUM-LAMP, WITH SPECIAL REFERENCE TO OPTICAL PYROMETRY.
D.C.Russell and F.H.Schofield.
Phil. Trans A (GB), Vol. 252, 463-98 (May 5, 1960).

Gives a general theory designed for application to the heavy-current strip lamps which serve as standards for calibration and the fine filament lamps embodied in the pyrometers themselves. Assumptions are made regarding the properties of tungsten, namely, that resistivity and emissivity both vary directly as the absolute temperature, while thermal conductivity remains constant. These allow a complete solution of the main differential equation governing temperature distribution. A comparison of results obtained in this way with a few computations, specially undertaken without resort to the resistivity and emissivity assumptions, shows that the simplifications suffice for all practical purposes. Further, the general agreement between the calculated and observed characteristics of lamps suggests that no great error results from the assumption of constant thermal conductivity. However, other simplifications are also briefly considered. The problems treated on the basis indicated are: the distribution of temperature along a filament of known dimensions, carrying a constant current and with its ends at a constant temperature; the voltage on, and resistance of such a filament; the temperature coefficients of calibration, i.e. the change in maximum temperature with change in surrounding temperature with the filament run at constant amps, volts or ohms, as the case may be; modification of the abovementioned characteristics due to appreciable gradients in the leads, and the asymmetry of distribution induced by the Peltier and Thomson effects. These subjects are treated generally for short filaments and also for the simpler case of infinitely long filaments to which, in fact, many lamps tend to conform. In addition to these matters, which are all concerned with the steady state of temperature distribution, the approach to that state is considered under conditions giving an estimate of the maximum speed of response attainable in practise. Numerical examples of the formulae developed are given for typical lamps and some of these are compared with other calculations and with observations. For pyrometer lamps a table is given showing how their main characteristics can be estimated, with fair accuracy, merely from a knowledge of the filament dimensions, or, in the case of existing lamps, by means of a simple test. Suggestions are also made for possible modifications in the design of standard strip lamps.

8234 MICROWAVE DETERMINATION OF ELECTRON CONCENTRATIONS IN FLAME GASES USED AS A SPECTROSCOPIC LIGHT SOURCE.
F.W.Hofmann, H.Kohn and J.Schneider.
J. Opt. Soc. Amer., Vol. 51, No. 5, 508-11 (May, 1961).

Direct determinations of the concentration of electrons in flame gases were needed to justify the method, described in the preceding paper, to eliminate the distortion of intensity–density curves due to ionization of the metallic flame additives. Measurements of the attenuation of a microwave beam upon crossing a column of flame gases were performed, and electron concentrations in an acetylene–air flame (T = 2500°K) containing one or mixtures of two

alkali elements were obtained. The results indicate that the ionization of the metallic flame additives is thermally equilibrated in the flame zone chosen for the optical line-intensity measurements.

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

8235 FRINGES OF EQUAL INCLINATION IN THE DOUBLE-PASSED MICHELSON INTERFEROMETER.
P.Hariharan and D.Sen.
J. Opt. Soc. Amer., Vol. 51, No. 6, 617-19 (June, 1961).

A theoretical expression is obtained for the intensity distribution in the interference pattern. It is shown that the intensity distribution in these fringes undergoes a periodic modulation as the path difference in the interferometer is varied. Accurate measurements are possible with these fringes using a photometric setting criterion.

8236 RELATION OF BLUR FUNCTIONS TO RESOLVING POWER. G.A.Fry.
J. Opt. Soc. Amer., Vol. 51, No. 5, 560-3 (May, 1961).

The type of blur involved in an optical image can be specified by describing the distribution of illuminance across the image of a narrow line. This is called the blur function. If the blur function conforms to the normal curve, the image of a grating will gradually fuse as the spacing decreases without undergoing "spurious resolution." This property of a Gaussian blur function makes it possible to use it in analysing the effects obtained with other types of blur. This approach to the problem also explains why there is a poor correlation between the resolution of gratings and the Cobb–Fry index of blur.

8237 LIGHT DIFFRACTION BY PROGRESSIVE ULTRASONIC WAVES IN PLEXIGLAS.
W.G.Mayer and E.A.Hiedmann.
Acustica (Internat.), Vol. 10, No. 4, 251-2 (1960).

The optical grating produced by a progressive ultrasonic wave in Plexiglas is used to verify directly the Raman–Nath theory (1935-6) for solids after it is shown that no finite amplitude distortion of the waveform is present. The absorption coefficient is determined by evaluating the diffraction pattern.

8238 MIE SCATTERING WITH COMPLEX INDEX OF REFRACTION. D.Deirmendjian, R.Clasen and W.Viezee.
J. Opt. Soc. Amer., Vol. 51, No. 6, 620-33 (June, 1961).

A new set of computations of the exact Mie functions, related to the scattering of electromagnetic waves on dielectric and partially absorbing spheres, is described. Numerical results with sufficient accuracy and detail in size and angular variation were obtained by means of the IBM-704 computer system for a set of complex indexes of refraction and size ranges mainly corresponding to atmospheric particles illuminated by visible and infrared radiation. The effects of increased absorption index on the extinction and absorption cross-section, on the complex amplitude, and on the intensity and polarization of the scattered flux are illustrated by means of diagrams.

8239 THEORETICAL INVESTIGATIONS ON THE LIGHT SCATTERING OF COLLOIDAL SPHERES. XI. DETERMINATION OF SIZE DISTRIBUTION CURVES FROM SPECTRA OF THE SCATTERING RATIO OR FROM DEPOLARIZATION SPECTRA.
A.F.Stevenson, W.Heller and M.L.Wallach.
J. chem. Phys. (USA), Vol. 34, No. 5, 1789-95 (May, 1961).

For Pt X, see Abstr. 5360 of 1961. The theory of a method is developed by means of which size distributions in heterodisperse systems of colloidal and small microscopic spheres can be determined from spectra of the scattering ratio or depolarization. The method is applicable whenever the distribution is unimodal, positively skewed, and of the type most commonly found in emulsions. It makes use of the Mie scattering functions and encompasses α values up to 25.2 (diameters up to 3.3 μ if the vacuum wavelength is 5460.73 A) and the relative refractive indices m = 1.05 (0.05) 1.30. The method yields the mean number or weight average diameter, modal diameter, half-width, and "half-spread" of a distribution and, in addition, the diameter of the smallest particles present in consequential numbers. For those instances where the assumed type of distribution does not apply, an extension of the theory is provided which is based upon a linear combination of two distribution functions of the same type. It allows one, in principle, to consider also negatively skewed and bimodal distributions. Use of the linear combination is indicated only when failure to obtain a satisfactory fit between theoretical and experimental spectra shows nonvalidity, in a particular system, of the simple one term distribution function.

8240 THEORETICAL INVESTIGATIONS ON THE LIGHT SCATTERING OF COLLOIDAL SPHERES. XII. THE DETERMINATION OF SIZE DISTRIBUTION CURVES FROM TURBIDITY SPECTRA. M.L.Wallach, W.Heller and A.F.Stevenson.
J. chem. Phys. (USA), Vol. 34, No. 5, 1796-1802 (May, 1961).

The theory of a method is outlined which gives size distribution curves in heterodisperse systems of nonabsorbing colloidal and small microscopic spheres from measurements of turbidity spectra. The assumption is made that the distribution follows a function previously given which closely approximates that commonly found in emulsions. All the numerical data necessary for practical application of the method are provided for the relative refractive indices m = 1.05 (0.05) 1.30. They were obtained from the Mie theory. The method may be used independently, but is particularly useful in conjunction with an alternate method described in Pt XI (preceding abstract).

8241 SCATTERING OF ELECTROMAGNETIC WAVES FROM CONCENTRIC INFINITE CYLINDERS.
M.Kerker and E.Matijević.
J. Opt. Soc. Amer., Vol. 51, No. 5, 506-8 (May, 1961).

The solution for the scattering of radiant energy in the form of electromagnetic waves by concentric isotropic infinitely long circular cylinders is given for the incident energy travelling perpendicular to the cylinder axis.

8242 THE MULTIPLE SCATTERING OF WAVES BY WEAK RANDOM IRREGULARITIES IN THE MEDIUM.
I.D.Howells.
Phil. Trans A (GB), Vol. 252, 431-62 (May 5, 1960).

Extends ideas by Lighthill (Abstr. 8295 of 1953) and Fejer (Abstr. 2600 of 1954) and uses the equation of energy transfer for radiation in a uniform scattering atmosphere to describe the variation of average intensity in a randomly inhomogeneous medium. In Section I, the results of the single-scattering theory are reviewed, and an estimate is made of the conditions under which they should be correct. The justification for the treatment of multiple scattering by an equation of energy transfer is then discussed, and conditions under which it may be expected to be valid are obtained. In Section II, the general solution of the equation of transfer for a spatially homogeneous radiation field, varying with time, is given first, and compared with Lighthill's result for the angular distribution of radiation in terms of the length of path travelled. The much more difficult problem of a steady-state field with spatial variation is treated by Chandrasekhar [Radiative Transfer. Oxford: Clarendon Press (1950)], who gives many exact solutions for special types of scattering (such as isotropic and Rayleigh scattering). But his methods are not well suited to some other types, especially small-angle forward scattering. Most of Section II is devoted to finding approximate solutions for this case, first generalizing Fejer's solution for a slab of scattering medium which produces a small total angular deviation of the radiation, and then deriving an approximate partial differential equation of transfer to treat problems where the total angular deviation is not small. Methods of solving this equation by eigenfunction expansions are explained, and some numerical results are given, especially angular distributions of emergent and reflected radiation for a semi-infinite scattering region.

COLORIMETRY . PHOTOGRAPHY

8243 DIRECT-READING TOMATO COLORIMETER.
R.S.Hunter and J.N.Yeatman.
J. Opt. Soc. Amer., Vol. 51, No. 5, 552-54 (May, 1961).

Colour is a factor of primary importance in the market value of raw tomatoes. Yeatman, Sidwell, and Norris [Food Technology (USA), Vol. 14, 16 (1960)] have developed an equation for colour quality of raw tomatoes using purees of fresh fruit as specimens. The U.S. Department of Agriculture asked Hunter Associates Laboratory to design a photoelectric tristimulus instrument to measure this quality index directly. This was done by modifying the

Ohm's law analogue scales of the Hunter colour difference meter (Abstr. 4498 of 1959) to solve the tomato-colour equation in four steps.

8244 THE GRADATION AND INERTIA OF HURTER AND AND DRIFFIELD: A STUDY IN THEORY. C.Candler.
Austral. J. Phys., Vol. 14, No. 1, 160-73 (March, 1961).

In a deep emulsion the shape of the D—log E characteristic depends on two quantities, the photon number P, which is determined by the number of photons required to form a development centre, and the ratio K of the absorption cross-sections of a silver halide crystal before and after development. The position of the curve on the exposure axis is determined by the mean reaction cross-section s of the crystals. In a coating a fourth quantity enters, the "opacity before development" of Hurter and Driffield (1890), here called the exposure ratio R of front to back surface. If development changes K only the Hurter and Driffield laws governing gradation and inertia automatically follow. Experiments have shown that P, s, and R are independent of development in one or two emulsions, but the extension of this to all emulsions depends on the general validity of the two laws which Hurter and Driffield themselves established. In a Schumann plate the ratio D/D_S, where D_S is the saturation density, remains constant as development proceeds and the two laws are still valid.

8245 CORRELATION BETWEEN RANDOM-DOT SAMPLES AND THE PHOTOGRAPHIC EMULSION.
J.C.Marchant and P.L.P.Dillon.
J. Opt. Soc. Amer., Vol. 51, No. 6, 641-4 (June, 1961).

A method is described for producing samples of an "ideal model" of the developed photographic image (opaque circular dots distributed randomly over a clear background). The dots originate as random scintillations on the face of a cathode-ray tube and are recorded photographically. Expressions for density, root-mean-square density deviation, and Selwyn granularity are derived on the basis of the model. Samples produced by this method are shown experimentally to conform to the expected properties.

8246 ON QUESTIONS OF CHROMATICITY CALCULATIONS WITH SPECIAL REFERENCE TO PROBLEMS OF THE OPTICS OF THIN FILMS. H.Pohlack.
Jenaer Jahrbuch (Germany), 1959 I, 59-85. In German.

An analytical paper which has important bearing on the choice of materials in colour photography. R.A.Weale

THE DEVELOPMENT OF NUCLEAR EMULSIONS.
See Abstr. 7180

METHODS OF IMPROVEMENT OF THE QUALITY OF DEVELOPMENT OF THICK LAYERS OF EMULSION (400 MK).
See Abstr. 7181

8247 IMPROVED CINE PROJECTION OBJECTIVES FOR NEW FILM PROJECTION SYSTEMS.
H.Maenz, R.Tiedeken and R.Wanke.
Jenaer Jahrbuch (Germany), 1960 I, 53-65. In German.

A new lens, the 92 mm Visionar F/1.6, developed for wide-screen projection techniques, is compared with the 90 mm F/1.6 Prokinar for aberrations and image quality. Both are of the double Gauss type. W.T.Welford.

8248 MIRROR- VERSUS LENS-OBJECTIVE. H.Zöllner.
Jenaer Jahrbuch (Germany), 1960 I, 48-52. In German.

Describes an F/4 500 mm catadioptric objective for miniature cameras and an F/0.85 100 mm refracting objective for X-ray photography on 70 mm by 70 mm format. W.T.Welford

8249 A SIMPLE INEXPENSIVE AUTOMATIC CAMERA FOR PHOTOGRAPHING AT REQUIRED INTERVALS.
R.Ramanadham and K.Nagamuneswara Rao.
J. sci. industr. Res. (India), Vol. 20D, No. 4, 135-6 (April, 1961).

The shutter is always kept open and the object to be photographed is illuminated at required intervals. This is achieved by using a universal fractional horse power motor and a reduction gear system. During the interval between successive exposures the exposed paper will be wound up and the unexposed paper will be kept ready and stationary by the time the light for illuminating the object is switched on. The instrument can be used continuously with little personal attention.

TECHNIQUE FOR THE CINEPHOTOMICROGRAPHIC STUDY OF ETCHING PHENOMENA. See Abstr. 7844

HEAT . RADIATION

8250 HEAT TRANSFER DURING THE FLOW OF A LIQUID METAL IN THE LAMINAR AND TRANSITION REGIONS.
B.S.Petukhov and A.Ya.Yushin.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 6, 1321-4 (Feb. 21, 1961). In Russian.

Describes the method for measurements on mercury flowing in a mild carbon steel tube. The range was Pe (Peclet number) 14 to 600, Re (Reynolds number) 620 to 23 500, Prandtl number 0.021 to 0.026. In the laminar region Nu (Nusselt number) = 4.36 for $Re \leq 2300$, corresponding to $Pe \leq 55$. In the intermediate region $Nu = 4.36 + 0.0053\ Pe$, for Re 2300 to 23 500, corresponding to Pe 55 to 600. There is no sharp change in the Nu—Pe relation at the critical Reynolds number. The errors which can arise if heat flow along the axis is not prevented are discussed. [English translation in: Soviet Physics—Doklady (USA)]. R.Berman

8251 A UNIQUENESS THEOREM RELATING TO THE EQUATION OF CONDUCTION OF HEAT. M.Pagni.
Atti. Semin. Mat. Fis. Univ. Modena (Italy), Vol. 9, 24-31 (1959-60). In Italian.

The theorem relates to non-negative solutions continuous within the region bounded by $-\infty < x < +\infty$ and $0 < t \leq T$.
S.Weintroub

8252 INFLUENCE OF THE VARIATION OF THERMAL CONDUCTIVITY WITH TEMPERATURE ON THE PROPAGATION OF HEAT IN A PERIODIC MANNER.
L.Sicard, L.Eyraud, J.Elston and C.Eyraud.
J. Phys. Radium (France), Vol. 21, No. 10, 696–[illegible] Oct., 1960). In French.

The solution of the Fourier equation is not known in the case where the thermal conductivity coefficient of the materials is a function of the temperature. An approximate solution allows the calculation of the error incurred in the experimental determination of the thermal diffusivity coefficient by the method of Angstrom.

8253 THERMAL CONVECTION IN A ROTATING CIRCULAR PIPE WITH A CONSTANT TEMPERATURE GRADIENT (COMPRESSIBLE FLUID). V.N.Golubenkov.
Priklad. Mat i Mekh. (USSR), Vol. 22, No. 6, 840-1 (1958). In Russian.

Assuming small variations in temperature, velocity, pressure and density, the differential equation of the problem is solved in terms of a power series of the constant temperature gradient at the wall of the rotating pipe. The first approximation of the solution contains two terms: the first represents the free convection, the second the forced motion of the fluid due to the external pressure difference. Applied Mechanics Reviews

8254 DISCUSSION OF THE THEORIES OF CAVITY-TYPE SOURCES OF RADIANT ENERGY. C.S.Williams.
J. Opt. Soc. Amer., Vol. 51, No. 5, 564-71 (May, 1961).

This paper is a review of the theories of cavity-type radiant-energy sources that have properties approaching those of black bodies. Sources having highly emissive walls are distinguished from light wells, which have highly reflective walls. Certain theorems, which are aids in generalizing for forms other than simple geometrical shapes, are proved. The theories of Buckley, Gouffe, and De Vos are reviewed individually. The approximation involved in each theory is noted and the method appraised. Relationships for several cavity shapes are derived for computing the effective emissivity of the source in terms of dimensions of cavity, emissivity of walls lining the cavity, and aperture size.

U—B AND B—V COLOURS OF BLACK BODIES.
See Abstr. 8002

8255 DISCHARGE PHOTOCELLS FOR THE DETECTION OF RESONANCE RADIATION. W.E.Bell and A.L.Bloom.
J. appl. Phys. (USA), Vol. 32, No. 5, 906-9 (May, 1961).

Penning discovered that a discharge whose characteristics depend on maintenance of a population of metastables can have its operation altered drastically when the metastables are removed by incident light. A re-examination of the effect was made in the light of more modern techniques with a view toward developing a highly efficient, narrow-band photodetector. A detector was built with a sensitivity for the 20 581 A line of He comparable with that of commercially available detectors, but an acceptance bandwidth of only 0.1 cm^{-1}.

8256 TRANSDUCER FOR THE MEASUREMENT OF THERMAL POWER. B.L.Mattes and T.A.Perls.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 332-4 (March, 1961).

A transducer was developed to measure intense, transient heat levels, and designed to operate at close range in the heat environment generated by the Polaris missile at launch, but its use is readily adaptable to other similar requirements. Its main features as a transducer for measurement of thermal power are: (1) broad spectral sensitivity, (2) fast transient response (less than 1 msec for 63% response for the transducer described, while the inherent response time of the material is less than 12 μsec), (3) ability to withstand intense heat levels for short periods (600 W/in.^{2} for 0.5 sec), (4) continued use for succeeding tests without need for recalibration, and (5) ease of installation, requiring a minimum in circuitry to record the heat levels. The transducer consists of a pyroelectric ceramic disk placed in a shock isolation mount. The ceramic disks used were either barium titanate or lead zirconate-titanate, depending upon the thermal power level.

STABILITY OF LAMINAR FLAMES. See Abstr. 7907

ELECTRICAL CONDUCTIVITY IN FLAME GASES WITH LARGE CONCENTRATIONS OF POTASSIUM. See Abstr. 8167

8257 CORRECTED OPTICAL PYROMETER READINGS. D.E.Poland, J.W.Green and J.L.Margrave.
Nat. Bur. Stand.(USA), Monogr. No. 30, 1-74 (1961).

The table enables optical pyrometer users to convert observed temperature immediately to the true temperature, if the effective emissivity of the material being observed is known. It gives observed temperatures from 1 000° to 3 000° K in increments of 5 degrees, from 3 000° to 5 000° K in increments of 10 degrees, from 5 000 to 10 000° K in increments of 50 degrees, and from 10 000° to 39 900° K in increments of 100 degrees. For these, true temperatures are tabulated for 49 emissivities ranging from 0.02 to 0.98 in increments of 0.02. These calculations were made on a 650 electronic computer using Planck's law, and the value C_2 = 1.438 cm deg for the radiation constant.

8258 A CONSTANT ICE-POINT JUNCTION FOR THERMOCOUPLES IN CONTINUOUS USE FOR LONG PERIODS. T.N.Seshadri and S.P.Jain.
J. sci. industr. Res. (India), Vol. 20D, No. 4, 161-2 (April, 1961).

A device for recording continuously the thermoelectromotive forces for long periods is described. The system has been found to work satisfactorily for about 60 hr continuously in midsummer and for about 72 hr at other times.

8259 ANALYSIS OF "IMMERSED" THERMOCOUPLE ERROR. J.E.Bauerle.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 313-16 (March, 1961).

The error of an "immersed" thermocouple due to heat leaks through the thermocouple wires has been estimated by means of a simple model. The error is shown to decrease exponentially with quantity L_1/l_1 where L_1 is the "immersion" depth of the thermocouple and l_1 is a characteristic length depending on thermocouple parameters and the mode of heat transfer. It is shown that large errors generally arise if such a thermocouple is used in vacuum. Calculations for specific cases are given.

8260 THE BEHAVIOUR OF TWO-VALUED RESPONSE REGULATORS APPLICABLE TO ADIABATIC CALORIMETERS. A.J.B.Cruickshank.
Phil. Trans A (GB), Vol. 253, 407-58 (April 27, 1961).

The method is based upon the concept of "uniform operation" and uses an approximate description of the thermal conduction process which determines the operation of the regulator. The physical basis of this approximation is discussed in detail and it is shown that the same formal description of the conduction process is obtained in two different physical situations, although the probable accuracy of the approximation is different in two cases. In the case where the probable error is greater, the results when the approximation is applied to a linear response thermostat regulator are compared with those obtained by an exact treatment. In the adiabatic calorimeters, the heat change which would be observed under ideally adiabatic conditions may be computed as the sum of that actually observed and a correction term which, in general, has to be calculated for each experiment. The approximate analysis indicates that with one special type of two-valued response regulator this correction term is proportional to the heat change actually observed, the constant of proportionality depending only on measurable physical characteristics of the apparatus. The correction term is subject to an uncertainty, the estimation of which is discussed in appendix I. With the other two-valued response regulators the correction term can only be evaluated in terms of the detailed behaviour of the regulator during the experiment. It is shown that in these cases it is sufficient to know, in addition to the relevant physical characteristics of the apparatus, the way in which the ratio of positive and negative half-cycle periods of the regulator varies with time during the experiment. The half-cycle periods can usually be observed directly; but a numerical integration has to be carried out for each experiment. The analysis is extended to take account of time delay in the regulator servomechanism, and the effects of time delay are discussed in terms of numerical examples. A similar discussion is developed also for the use of an auxiliary signal to improve the performance of regulators of this type. It is shown that while this device always reduces the amplitude of the temperature oscillation, the mean temperature may be less accurately controlled than in the absence of the device. The predictions of the approximate analysis concerning the behaviour of two-valued response regulators are compared with experimental results obtained from an externally compensated adiabatic calorimeter and from various thermostats. The agreement appears to be satisfactory. The numerical evaluation of performance data for a simple two-valued response regulator is discussed in detail in appendix II, which includes tabulated solutions to the equations describing the behaviour of the regulator. When the values of the relevant physical characteristics of a particular apparatus are known, together with the variation of the ratio of positive and negative half-cycle periods in a experiment, these tables may be used to compute the correction term to the observed heat change. The tables may also be used to calculate the difference between the mean temperature in a thermostat and the datum temperature for which the regulator is set in terms of the ratio of positive and negative half-cycle periods.

CHANGE OF STATE

(Solid-state phase transformations are included primarily under Structure of Solids)

8261 NOTE ON THE SUBLIMATION OF AMMONIUM PERCHLORATE. H.M.Cassel and I.Liebman.
J. chem. Phys. (USA), Vol. 34, No. 1, 343 (Jan., 1961).

Work by Galway and Jacobs [Journal of the Chemical Society, 837 (1959)] indicated that ammonium perchlorate sublimed undissociated and that the precipitation of a liquid phase preceded crystallization. It now appears that the decomposition reaction proceeds as follows:

$$NH_4ClO_4 = (HClO_4 + NH_3)/6 + 5\ (HNO_3 + HCl + H_2O)/6,$$

in which only one-sixth of the reaction is simple dissociation.

H.H.Hodgson

8262 VAPOUR PRESSURE OF ISOTOPIC LIQUIDS. III. SOME CORRECTIONS TO PREVIOUS PAPERS. G.Boato, G.Casanova, G.Scoles and M.E.Vallauri.
Nuovo Cimento (Italy), Vol. 20, No. 1, 87-93 (April 1, 1961).

For Pt II, see Abstr. 14683 of 1960. Errors in the derivation of $\ln p_A/p_B$ from the measured α are pointed out. As a consequence, the claimed linear dependence of $\ln p_A/p_B$ on 1/T for argon and neon is to be questioned. The corrected results agree with the measurements by Roth and Bigeleisen (Abstr. 8700 of 1960), carried out on liquid neon by a direct method.

8263 VAPORIZATION OF SEVERAL RARE EARTH OXIDES. M.B.Panish.
J. chem. Phys. (USA), Vol. 34, No. 3, 1079-80 (March, 1961).

This was studied for Pr_2O_3, Nd_2O_3, Sm_2O_3, and Er_2O_3 at temperatures ranging from 1950° to 2350° K by analysing the species effusing from a Knudsen effusion cell with a Bendix time-of-flight mass spectrometer. The results indicate that the vaporization proceeds by means of the reaction $M_2O_{3(s)} \rightarrow 2M_{(g)} + 3O_{(g)}$.

W.Good

8264 ENTROPIES OF VAPORIZATION OF HYDROCARBONS AND THE HILDEBRAND RULE.
R.W.Hermsen and J.M.Prausnitz.
J. chem. Phys. (USA), Vol. 34, No. 3, 1081-3 (March, 1961).

Using the highly accurate vapour pressure and other data now available on hydrocarbons the entropies of vaporization are calculated for 21 of these substances at a saturated vapour volume of 49.5 litre/gram mole (the volume previously used by Hildebrand). The entropies are accurate to ±0.1 cal gram mole^{-1} deg^{-1} K. "Excess" (to that of methane) entropies are discussed. Unexpectedly neopentane, which because of its approximately spherical shape was thought to be very similar in its properties to methane, shows one of the largest negative "excess" entropies. W.Good

8265 DETERMINATION OF THE ENTROPY OF BOILING.
J.M.Živojinov.
J. Phys. Radium (France), Vol. 21, Suppl. No. 3, 37A-38A (March, 1960). In French.

An equation determining the relation between boiling temperature and the corresponding pressure is given:

$$\ln\frac{p_K}{p} = a\left(\frac{T_K}{T} - 1\right)^n .$$

The index n and constant a are used to calculate the entropy of boiling for water and ethyl alcohol. The results are in better agreement with experimental values than those given by Milosavljevic's equation (Abstr. 2872 of 1947).

8266 STUDIES ON THE FREEZING OF PURE LIQUIDS. I. CRITICAL SUPERCOOLING IN MOLTEN ALKALI HALIDES. E.R.Buckle and A.R.Ubbelohde.
Proc. Roy. Soc. A (GB), Vol. 259, 325-40 (Dec. 29, 1960).

A high-temperature cloud chamber is described in which a bead of alkali halide is supported on a heater coil mounted in the roof. By passing the current through the coil the temperature of the bead may be momentarily raised by several hundred degrees, producing salt vapour at high supersaturation. Condensation ensues in the presence of the inert supporting gas, and clouds of droplets or solid particles appear depending on the chamber temperature. Light scattered from the clouds under strong illumination is examined with a telescope, and the presence of crystalline particles is detected by their capacity to scintillate, or "twinkle". It is found that twinkling in clouds of alkali halides appears sharply as the temperature is lowered below the melting point, defining a critical temperature of solidification for each salt. Reasons are given for regarding this temperature as the freezing threshold of molten salt droplets, for which supercoolings of about 150° C are indicated. A reduced temperature, given by the ratio of the freezing threshold to the melting point, has the value of approximately 0.8 for all the alkali halides examined.

THERMODYNAMICS

(See also Statistical Mechanics)

8267 ON INTERSECTING ISENTROPICS.
J.Kestin.
Amer. J. Phys., Vol. 29, No. 5, 329-32 (May, 1961).

It is explained that two isentropic lines can intersect (when they both lie on the same surface of constant entropy).
P.T.Landsberg

8268 THE SECOND LAW OF THERMODYNAMICS.
B.Crawford, Jr and I.Oppenheim.
J. chem. Phys. (USA), Vol. 34, No. 5, 1621-3 (May, 1961).

Derivations of the mathematical statement of the second law of thermodynamics from the physical statements of Kelvin and Clausius are presented. Caratheodory's principle is obtained as a direct consequence of either Kelvin's or Clausius's statement.

8269 THE THERMODYNAMICS OF PHASE EQUILIBRIUM.
L.Tisza.
Ann. Phys. (USA), Vol. 13, No. 1, 1-92 (April, 1961).

The Gibbsian thermodynamics of phase equilibrium is distinguished from the thermodynamics of Clausius and Kelvin. The latter was put into an axiomatic form by Carathéodory; the present paper attempts a similar task for the Gibbs theory. The formulation of this theory as an autonomous logical structure reveals characteristic aspects that were not evident until the two logical structures were differentiated. The analysis of the basic assumptions of the Gibbs theory allows the identification and removal of defects that marred the classical formulation. In the new theory thermodynamic systems are defined as conjunctions of spatially disjoint volume elements (subsystems), each of which is characterized by a set of additive conserved quantities (invariants): the internal energy, and the mole numbers of the independent chemical components. For the basic theory, it is convenient to assume the absence of elastic, electric, and magnetic effects. This restriction enables the definition of the thermodynamic processes as transfers of additive invariants between subsystems. Following Gibbs, it is postulated that all thermostatic properties of system are contained in a fundamental equation representing the entropy as a function of the additive invariants.

NON-EQUILIBRIUM THERMODYNAMICS OF ELECTROKINETIC PHENOMENA. See Abstr.8303

LOW-TEMPERATURE PHYSICS

Liquid and Solid Helium

8270 THEORY OF NEGATIVE IONS IN LIQUID HELIUM.
C.G.Kuper.
Phys. Rev. (USA), Vol. 122, No. 4, 1007-11 (May 15, 1961).

It is shown that Atkins' electrostriction model (Abstr. 2285 of 1960) gives reasonable values for the mobility of positive ions in liquid helium. However, that model cannot account for the observed difference betweem positive- and negative-ion mobilities. Arguments are advanced in support of the "bubble" model; the negative ion is believed to be a free electron in a cavity of radius about 12 A. The bubble model leads to a mobility in fair agreement with experiment.

8271 IONIC RECOMBINATION IN LIQUID HELIUM.
G.Careri and F.Gaeta.
Nuovo Cimento (Italy), Vol. 20, No. 1, 152-60 (April 1, 1961).

The volume recombination coefficient of ions in liquid helium II was measured down to 0.8°K by a new experimental procedure. The results can be well interpreted in terms of the Langevin and Harper theories usually valid for ordinary gases, the excitations taking now the role of the neutral molecules and the superfluid phase the place of the empty space.

8272 THERMODYNAMIC PROPERTIES OF LIQUID ^{3}He–^{4}He MIXTURES DERIVED FROM SPECIFIC HEAT MEASUREMENTS BETWEEN 0.4°K AND 2°K OVER THE COMPLETE CONCENTRATION RANGE.
R.de Bruyn Ouboter, K.W.Taconis, C.le Pair and J.J.M.Beenakker.
Physica (Netherlands), Vol. 26, No. 11, 853-88 (Nov., 1960).

Heat capacities were measured using a calorimeter that can be cooled by means of evaporation of He^3. Special attention was given to the additional contribution to the specific heat due to the heat of mixing which is observed when stratification takes place below the phase separation temperature and to the discontinuity in the specific heat at the corresponding lambda temperature. The heat of mixing can be derived from the specific heat measurements inside and outside the phase separation region. The excess entropy was calculated. For dilute mixtures of He^3 in liquid He^4 at temperatures below 1°K the energy spectrum of Pomeranchuk seems to be satisfied.

8273 COMMENTS ON THE THEORY OF THE STATIC HELIUM FILM.
H.Matsuda and C.J.N.van den Meijdenberg.
Physica (Netherlands), Vol. 26, No. 11, 939-48 (Nov., 1960).

Some discrepancies in the theories of the static helium film are discussed. Both Atkins (Abstr. 6573 of 1954) and Franchetti's (Abstr. 2127, 8163 of 1957) theories are criticized. Considering again the effects of Van der Waals forces and acoustical zero point energy, a new derivation is given of formulae for the equilibrium film profile and the density in the film near 0°K. The formula for the profile can be fitted to the experimental results of Ham and Jackson.

:NCE OF ^{3}He ON FILM FLOW.
en Meijdenberg, K.W.Taconis and C.Le Pair.
'ol. 27, No. 1, 117-42 (Jan., 1961).
of the film in equilibrium with liquid
was investigated in the temperature range
temperature. The flow rate was found to
erature, the concentration and the height
.d level, but independent of the pressure
be described by the simple formula,
al: $\sigma = A\rho_S/\rho$, where A is a constant
ıe variation of the flow rate with the height
)end on both temperature and concentration.
:ts, including the present one, are considered
f the two-fluid model.

[ODYNAMIC CONSIDERATIONS ON THE
OF LIQUID ^{3}He–^{4}He MIXTURES.
.J.M.Beenakker.
1. 27, No. 2, 219-29 (Feb., 1961).
ve for liquid He^3–He^4 mixtures shows a
with the lambda curve as can be seen on
ynamic considerations. If the lambda
n curve meet each other under a finite
:uity in the slope of the stratification curve
this point. Furthermore, the entropy of
ilute mixtures is discussed with respect to Nernst's theorem.

8276 SPECIFIC HEAT AND THERMAL BOUNDARY RESISTANCE OF LIQUID He^3.
.C.Anderson, G.L.Salinger, W.A.Steyert and J.C.Wheatley.
hys. Rev. Letters (USA), Vol. 6, No. 7, 331-4 (April 1, 1961).

The specific heat was measured between 0.008 and 0.04°K at a ressure of about 14 cm Hg. It can be expressed by $c_p = (19.3 \pm 1.6)T$ Joule/mole deg^2, slightly higher than the extrapolated value given by Brewer et al. (Abstr. 223 of 1960). No vidence was found for a transition to a highly correlated phase. he heat transfer between the container, which was made of pibond 100A, and the He^3 could be determined between 0.019 and .041°K. It can be represented by $\dot{q} = 7.2 \times 10^4 (T^4 - T_{cold}^4)$ rg sec^{-1}cm^2 deg^4. Here T and T_{cold} are the temperatures on the vo sides of the boundary, T_{cold} being the colder. This result in qualitative agreement with calculations by Bekarevich and halatnikov [Zh. eksper teor. Fiz. (USSR), Vol. 39, No. 6(12). 699 (Dec., 1960)]. H.London

8277 SPECIFIC HEAT OF LIQUID He^3 DOWN TO 0.054°K.
M.Strongin, G.O.Zimmerman and H.A.Fairbank.
hys. Rev. Letters (USA), Vol. 6, No. 8, 404-6 (April 15, 1961).

These measurements bridge the gap between the temperature ange of the preceding abstract and Abstr. 223 of 1960. The pecific heat becomes linear below 0.09°K with a slope of .38 cal/mole deg^2 as compared with 4.61 and 4.00 cal/mole deg^2 espectively in the two papers quoted. The entropy calculated rom the specific heat is 0.4378 cal/mole deg at 0.1°K and 0.918 t 0.23°K. This may be compared with the figures 0.400 and .86 of Abstr. 223 of 1960. H.London

8278 THE ENTROPY OF HELIUM II UNDER PRESSURE FROM MEASUREMENTS ON THE FOUNTAIN EFFECT.
C.J.N.van den Meijdenberg, K.W.Taconis and R.de Bruyn Ouboter.
Physica (Netherlands), Vol. 27, No. 2, 197-218 (Feb., 1961).

Assuming that London's formula, $\Delta p = \rho S \Delta T$, is also valid for he fountain effect in helium II at high pressures, the entropy as a unction of temperature and pressure was evaluated from measurements of the fountain effect in the temperature range 1.15-2.00°K nd at various pressures between the saturated vapour pressure nd 25 atm. On extrapolating the entropy data as a function of ressure to the saturated vapour pressure good agreement is found vith the entropy values of Kramers et al, the deviations being maller than 2%. The entropy data of Lounasma and Kojo (Abstr. 228 of 1960) at different densities are fitted to the present entropy ata to obtain an entropy diagram up to the λ-curve. As, however, he various data on the density of liquid helium do not agree there s some doubt with respect to this fit. Finally, values have been etermined for the parameters of the roton spectrum at several ressures. The results are discussed and compared with those btained from experiments on inelastic neutron scattering.

8279 CRYSTAL STRUCTURE OF THE β FORM OF He^4.
R.L.Mills and A.F.Schuch.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 263-4 (March 15, 1961).

X-ray oscillation photographs of solid He at 16°K and 18 440 lb/in^2 pressure confirm that the β-phase has the expected f.c.c. structure. R.G.Chambers

8280 NEW SOLID PHASE IN He^4.
J.H.Vignos and H.A.Fairbank.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 265-7 (March 15, 1961).

Velocity of sound measurements have revealed a first-order transition to a new solid phase (γ-phase) between 1.45°K and 1.78°K in a narrow range of pressures along the melting curve. The molar volume of the γ-phase is roughly 0.3% greater than that of the α-phase. The melting curve shows a discontinuity in slope at the α–γ–liquid triple point. The γ-phase is thought to be b.c.c. in structure. R.G.Chambers

LATTICE THERMAL CONDUCTIVITY OF SOLID HELIUM ISOTOPIC MIXTURES. See Abstr. 7544

Superconductivity

8281 NOTES ON THE THEORY OF MEISSNER EFFECT.
M.Asami and F.Takano.
J. Phys. Soc. Japan, Vol. 15, No. 4, 669-77 (April, 1960).

The gauge invariance of the Bardeen, Cooper and Schreiffer explanation of the Meissner effect (Abstr. 1708 of 1958) is guaranteed by the inclusion of the collective excitations, as shown by Anderson (Abstr. 5010 of 1958) and Yoshida (Abstr. 19554 of 1960). In this case, however, the current, which can be neglected in B.C.S. calculation, might begin to make a finite contribution to the Meissner effect. It is shown that this is actually the case in a system of normal electrons with Coulomb interactions. The situation in superconductors does not seem to differ essentially from that of normal electrons with this respect. This conclusion means that the gauge invariant theory of the Meissner effect cannot be said to be complete unless this difficulty is solved. Moreover, the canonical transformation leading to the B.C.S. model adds some terms to the current operator. The magnitude of these terms is estimated, and is shown to make a numerically small but finite contribution to the Meissner effect also.

8282 MAGNETIC FIELD DEPENDENCE OF THE SUPERCONDUCTING ENERGY GAP. D.H.Douglass,Jr.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 346-8 (April 1, 1961).

The Ginzburg–Landau theory is used to predict the dependence of the energy gap on magnetic field near the critical temperature. The energy gap decreases smoothly, going down to zero at the critical field if the specimen is thinner than a certain fraction of the penetration depth, and to a finite value for thicker specimens. Experiments on thin films confirm that the gap goes to zero, but do not agree in detail with the theory. This calculation disagrees with that of Gupta and Mathur (Abstr. 1859 of 1961).

D.J.Thouless

8283 SIGN REVERSAL OF THE MAGNETIC FIELD IN THE MEISSNER EFFECT. I. SPECULAR SURFACE SCATTERING [OF ELECTRONS]. R.Sommerhalder and H.Thomas.
Helv. phys. Acta (Switzerland), Vol. 34, No. 1, 29-35 (1961). In German.

The penetration of a longitudinal magnetic field through the wall of a superconducting hollow cylinder is calculated for an arbitrary nonlocal theory, assuming specular reflection of the electrons at the surfaces. Numerical analysis for the case of Pippard's kernel predicts opposite signs of the magnetic fields inside and outside the cylinder above a certain critical wall thickness, which depends on the coherence length. The calculated field attenuation ratio should allow experimental observation of this sign reversal for evaporated films, thus providing a direct proof of the nonlocal relation between vector potential and density of the supercurrents.

8284 STUDY OF SUPERCONDUCTORS BY ELECTRON TUNNELING. I.Giaever and K.Megerle.
Phys. Rev. (USA), Vol. 122, No. 4, 1101-11 (May 15, 1961).

If a small potential difference is applied between two metals separated by a thin insulating film, a current will flow due to the quantum mechanical tunnel effect. For both metals in the normal state the current–voltage characteristic is linear, for one of the

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metals in the superconducting state the current–voltage characteristic becomes nonlinear, and for both metals in the superconductive state even a negative-resistance region is obtained. From these changes in the current–voltage characteristics, the change in the electron density of states when a metal goes from its normal to its superconductive state can be inferred. By using this technique the energy gaps in metal films 1000-3000 A thick at 1°K were found to be: $2\epsilon_{Pb} = (2.68 \pm 0.06) \times 10^{-3}$ eV, $2\epsilon_{Sn} = (1.11 \pm 0.03) \times 10^{-3}$ eV, $2\epsilon_{In} = (1.05 \pm 0.03) \times 10^{-3}$ eV, and $2\epsilon_{Al} = (0.32 \pm 0.03) \times 10^{-3}$ eV. The variation of the gap width with temperature is found to agree closely with the Bardeen–Cooper–Schrieffer theory (Abstr. 1708 of 1958). Furthermore the energy gap in these films was found to depend upon the applied magnetic field, decreasing with increasing field.

8285 ABSENCE OF AN ISOTOPE EFFECT IN SUPERCONDUCTING RUTHENIUM.
T.H.Geballe, B.T.Matthias, G.W.Hull, Jr and E.Corenzwit.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 275-7 (March 15, 1961).

Within an accuracy of 0.001 deg, naturally occuring ruthenium and its isotopes of mass 99 and 104 have identical superconducting temperatures. The inverse square-root law would give a shift of 0.012° between Ru^{104} and Ru^{99}. This is considered as an indication that mechanisms other than electron–phonon interaction may also lead to superconductivity, for instance s–d interaction.

H.London

ELECTRICITY
ELECTRICAL MEASUREMENTS AND CIRCUITS

8286 MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY AND DIELECTRIC CONSTANT WITHOUT CONTACTING ELECTRODES. T.Ogawa.
J. appl. Phys. (USA), Vol. 32, No. 4, 583-92 (April, 1961).

A method is developed whereby electrical conductivity and dielectric constant of semiconducting and dielectric materials can be measured without contacting electrodes. A specimen suspended in a rotating field with a fine fibre is rotated by the torque proportional to the electrical conductivity or the imaginary part of its complex dielectric constant, and the torque exerted on it by a linearly polarized field is proportional to the real part of its dielectric constant. An analysis of the method and some preliminary measurements of conductivity, photoconductivity, the dielectric constant of cadmium sulphate crystals and the dielectric loss of the lamella containing CdS powder are presented. The latter shows the photodielectric effect.

8287 MEASUREMENT OF HIGH ELECTRIC RESISTANCES USING AN IONIZATION CHAMBER AS A SOURCE OF CURRENT. D.Blanc, E.Fort, R.Lacoste and J.Lagasse.
J. Phys. Radium (France), Vol. 21, Suppl. No. 3, 52A-56A (March, 1960). In French.

The accurate measurement of high electric resistances is difficult when their values are above 10^{12} Ω. A method using an ionization chamber as a current source, put into series with the unknown resistance, is used and the value of this resistance is calculated from the voltage between its terminals, measured with an electrometer. The ionization chamber is filled with air or argon; its electrodes are two parallel plates, the spacing of which can be varied. Constant ionization current supplied by the system is provided by a thin layer of uranium dioxide, deposited on one side of a plate. If the filling pressure is modified, the ionization current can be continuously varied; its maximum value is 2.7×10^{-11} A, under atmospheric pressure. This method allows measurement with great accuracy of resistances which have small values as compared to the internal resistance ρ of the chamber ($\rho = \Delta V/\Delta i$). Under atmospheric pressure, ρ is of the order of 10^{15} Ω; with air, under a pressure of 2 cm of mercury, ρ will be 10^{16} Ω. The upper limit of resistances which can be measured accurately, with this ionization chamber, is 10^{14} Ω.

8288 HIGH PRESSURE ELECTRICAL RESISTANCE CELL, AND CALIBRATION POINTS ABOVE 100 KILOBARS.
A.S.Balchan and H.G.Drickamer.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 308-13 (March, 1961).

A high pressure electrical cell is described consisting of tapered Carboloy pistons supported by a pyrophyllite pellet. The pistons are heavily work hardened. A calibration is obtained based on the barium transition at 59 kb, the bismuth transition at 90 kb, and an extrapolation of Bridgman's data. The pressure range is to 500 kb under favourable circumstances. New fixed points include a discontinuous rise in resistance of lead at 161 kb, a discontinuous rise in resistance of barium at 147 kb, a discontinuous rise in the resistance of rubidium at 193 kb, a maximum in the resistance of calcium at 370-75 kb, and a maximu in the resistance of rubidium at 425 kb. In addition, there is a discontinuous rise in resistance of iron at 133 kb which is consist with the shock wave pressure point found at 131 kb and 37°C.

8289 VARIABLE, PRECISION REGULATED, LOW VOLTA HIGH CURRENT SUPPLY FOR LARGE ELECTROMAGNETS. R.C.Mobley.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 432-3 (April, 1961).

A hybrid combination of electronic and magnetic amplifiers h been successfully and reliably utilized for five years in a variabl precision regulated, low-voltage high-current supply for a charge particle deflection magnet. The controlled current range is 5-20 at up to 40 V. Despite the nonlinear impedance presented by the magnet's shielded coils, appropriate feedback loops permit an essentially critically damped 0.01% control response throughout the entire current range. As crucially reflected in the magnet's field, regulation and ripple are < 0.01%.

8290 THE BLOCKING INDUCTOR IN THE MAGNET SUPPLY CIRCUIT OF THE ITALIAN 1000 MeV SYNCHROTRON. R.Marenesi, G.Sacerdoti and R.Toschi.
Elettrotecnica (Italy), Vol. 47, No. 6, 432-42 (June 10, 1960). In Italian.

The magnets are fed with superimposed a.c. and d.c. In seri with the d.c. supply is an antiresonant circuit which blocks the a. circuit. The inductor has to carry a direct current of 2715 A and an alternating voltage of 4615 V. The design of this inductor is described.

V.G.Weiss

8291 A TWO-DIMENSIONAL KICKSORTER WITH MAGNETIC DRUM STORAGE. R.L.Chase.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 223-31.

The instrument is designed to analyse two inputs which repre sent two parameters of a nuclear event. Each input passes throug a pulse height-to-time convertor consisting of an amplifier, a run down capacitor and a gated multivibrator clock. The magnetic dr memory has 3072 channels each with a capacity of 16 binary bits. Writing and reading are effected by a "single pass" method, maki use of precursor signals obtained shortly before the optimum time for rewriting. In the display first used with the analyser the x and y coordinates correspond to the x and y components of the address and the beam intensity is an analogue representation of the count stored in each address. Because of the non-linear c.r.t. characte tic and the subjective nature of estimates of brightness, this displ is only qualitative. In an alternative display the count voltage is added to the y deflection voltage instead of controlling the intensit and gives a family of curves.

W.G.Str

8292 TRIGGER FEED OF A PAIR OF GEIGER–MÜLLER COUNTERS. L.Mitrani and B.Betev.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 64-6 (Nov.-Dec.). In Russian.

Two counters are connected by means of an Eccles–Jordan circuit giving artificial quenching of the discharge. The operatic of the counters is similar to that secured by pulsed feed, but the feed-voltage frequency automatically changes when the intensity be determined changes, and the readings do not depend on the fil factor. A scaling factor of 4 is obtained by means of two tubes. The dead time is shorter than when two counters work in paralle The output pulses are shaped with a large amplitude, which make it easy to register the pulses. [English translation in: Instrum. exper. Tech. (USA), No. 6, 924-6 (Nov.-Dec., 1959; publ. Sept., 1960)].

M.W.Mako

AN AUTOMATIC COUNTER CHRONOGRAPH FOR ROUTINE MEASUREMENTS OF SHORT INTERVALS OF TIME.
See Abstr. 8092

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

8293 PROGRESS IN DIELECTRICS. VOLUME 2. Edited by J.B.Birks and J.H.Schulman.
ɔndon: Heywood (1960) 225 + vii pp.
For abstracts of the papers in the above Volume see Abstr. 12-13, 7603, 7681-2, 7687 of 1961.

8294 PROGRESS IN DIELECTRICS. VOLUME 3. Edited by J.B.Birks and J.Hart.
ɔndon: Heywood (1961) 292 + vii pp.
For abstracts of some of the papers in the above Volume see ɔstr. 6868, 7014, 7151, 7683, 7693 of 1961.

8295 DYNAMIC INTERACTION FIELDS IN A TWO-DIMENSIONAL LATTICE. R.E.Collin and W.H.Eggimann.
:E Trans Microwave Theory and Tech. (USA), Vol. MTT-9, ɔ. 2, 110-15 (March, 1961).
In the theory of artificial dielectrics and aperture coupling in ɛctangular waveguides, a knowledge of the dynamic interaction ɛlds is required in order to evaluate the polarizing fields. This ıper presents suitable methods for evaluating the dynamic in-raction fields in a two-dimensional lattice. Both electric and mag-ɛtic dipoles are considered. The results are presented in closed rm apart from correction terms involving rapidly converging ɛries. Cross-polarization interaction constants are also evaluated.

8296 APPLICATION OF FERROELECTRICITY TO ENERGY CONVERSION PROCESSES.
.H.Clingman and R.G.Moore, Jr.
appl. Phys. (USA), Vol. 32, No. 4, 675-81 (April, 1961).
The principles of the conversion of heat energy directly into ɛctrical energy by use of a ferroelectric material heat-cycled in e neighbourhood of its Curie point are described. A simplified ɛpression for the energy conversion efficiency is derived, and rea-ɔnable values for appropriate parameters are used to obtain a ɯerical value for the efficiency under given operating conditions. ıe inadequacies of this simplified expression are discussed, and a ɔneral expression is derived. The results of the general analysis ɛe compared with those based on the simplified method. The analy-s shows that for barium titanate the exact theory predicts a higher ɛficiency than the simplified theory, and that in general the efficiency ɛcreases with increasing externally applied electric field and with ɛcreasing heat source temperature. For feasible operating con-tions, the efficiency is in the range of 0.5-1.0%. Future possibilities ɾ ferroelectric energy converters are discussed.

CURRENT ELECTRICITY ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

8297 SAMPLING TECHNIQUE FOR GENERATING GAUSSIAN NOISE. A.J.Rainal.
ɛv. sci. Instrum. (USA), Vol. 32, No. 3, 327-31 (March, 1961).
A sampling technique for generating Gaussian noise having ıiform power spectral density from approximately 0.1 c/s to kc/s is described. In principle the uniform power spectral ɔnsity property could be extended at both ends of the spectrum. ıe only nonlinear circuit required to implement the technique is simple high level sampling circuit. Random noise is periodically ımpled in order to generate a pulse train having short pulse ɪrations and statistically independent pulse amplitudes. The ɔndom pulse train is then applied to a low pass filter in order to ɔoduce a Gaussian distributed output as is predicted by the central mit theorem of probability. The technique is also useful for udying periodic overlapping impulse noise.

8298 ON THE QUANTUM THEORY OF ELECTRICAL CONDUCTIVITY. E.Verboven.
ɲysica (Netherlands), Vol. 26, No. 12, 1091-1116 (Dec., 1960).
The Kubo formula which gives in closed form a very general ɛpression for the electrical conductivity tensor, is simplified. A first simplification is of general nature and replaces the double integration in the original formula by a single one. A second reduction is performed in the one electron approximation. The formula there obtained is evaluated using and extending Van Hove's methods (Abstr. 7706 of 1955) for deriving the master equation. For simplicity the evaluation is restricted to the case of elastic scattering by static impurities. The conductivity tensor is calculated up to zeroth order, correcting and extending an incomplete discussion by Chester and Thellung (Abstr. 6905 of 1959) based on the same techniques. The lowest order term (of order -2) reproduces the result usually obtained by the Boltzmann equation method. The order of magnitude of the next order term is governed by the dimensionless parameter $[\hbar/\tau(\eta)\eta]^{1/2}$ where $\tau(\eta)$ is the relaxation time taken at the Fermi surface and η the Fermi energy. This term may be important in explaining the electrical resistance of binary alloys with rather high resistivity.

8299 ON THE EQUIVALENCE OF CURRENT LOOPS AND MAGNETIC SHELLS. C.A.Hurst.
Austral. J. Phys., Vol. 14, No. 1, 188-90 (March, 1961).
A paradox in the theory of the magnetic effects of stationary currents is discussed and is shown to arise from the neglect of a singular magnetic field which is required to complete the equivalance of magnetic shells and current loops.

8300 CALCULATION OF THE MAXIMUM EFFICIENCY OF THE THERMIONIC CONVERTER. J.H.Ingold.
J. appl. Phys. (USA), Vol. 32, No. 5, 769-72 (May, 1961).
A theoretical analysis of the efficiency of a thermionic convertor is made in terms of the following parameters: V_a, the potential difference between the top of the potential barrier in the inter-electrode space and the Fermi level of the anode; V_L, the potential drop across a load impedance in series with the convertor; and V_l, the potential drop in the necessary electrical connection to the cathode. The analysis is carried out by developing an expression for the efficiency of the convertor and then maximizing this expression with respect to V_L and V_l. This method yields optimum values of load impedance, cathode lead geometry, and cathode work function in terms of V_a, cathode temperature, cathode emission constant (usually denoted by A), and effective emissivity of the cathode. A hypothetical example is worked out numerically and the results show that (1) a low value of V_a is required for high efficiency, and (2) relatively low values of cathode work function are required for maximum efficiency at ordinary cathode temperatures.

8301 RESPONSE OF A THERMOCOUPLE CIRCUIT TO NONSTEADY CURRENTS. T.T.Arai and J.R.Madigan.
J. appl. Phys. (USA), Vol. 32, No. 4, 609-16 (April, 1961).
The response of a thermocouple circuit functioning as a Peltier cooler to time-varying currents was determined by assuming that the current density could be represented by the sum of a d.c. and a time-varying component. The time-varying component took the form of either an impulse applied at time $t_0 > 0$, a square pulse lasting from t_0 to t_1, a step increase in the current at time t_0, or a sinusoidal ripple superposed on the d.c. current. The increased current results in an initial thermal cold spike at the cold junction, but the time-average temperature difference between the junctions is reduced unless the d.c. current is well below the optimum value. The possibility of using such thermal spikes in a very long wavelength infrared communications system or in synchronous detection is discussed. In the case of a sinusoidal ripple the temperature difference between the junctions may either follow the fluctuations in current or may not, depending on the time constant of the couple and the frequency of the a.c. signal. In the latter case the only effect is a reduction in the temperature difference between junctions by the additional Joule heating due to the a.c. component.

8302 AN ANALYSIS OF THE PERFORMANCE OF THERMOELECTRIC DEVICES MADE FROM LONG-LIFETIME SEMICONDUCTORS. R.N.Hall.
Solid-State Electronics (GB), Vol. 2, No. 2-3, 115-22 (March, 1961).
The performance of an ohmic—n—p—ohmic junction rectifier made from a long-lifetime semiconductor is analysed as a thermoelectric generator and as a refrigerator. An upper limit to the efficiency of this device is shown to be inferior to that of a conventional (zero-lifetime) thermoelement. Arguments are presented to show that any semiconductor device, in which non-equilibrium concentrations of minority carriers play a part in determining the electrical characteristics, will have a poor thermoelectric efficiency. It seems safe to make the generalization that lifetime is not an important material property for semiconductor thermoelements.

8303 NON-EQUILIBRIUM THERMODYNAMICS OF ELECTRO-KINETIC PHENOMENA.
R.P.Rastogi and R.C.Srivastava.
Physica (Netherlands), Vol. 27, No. 2, 265-72 (Feb., 1961).

The entropy production in the stationary state for various electrokinetic phenomena is examined from geometrical considerations. The form of phenomenological equations for the non-linear region is suggested and non-linear thermodynamics of electrokinetic phenomena is developed. The domain of validity of Saxen's relations is examined.

MOBILITY OF CHROMIUM ATOMS IN A NICKEL—CHROMIUM ALLOY UNDER THE INFLUENCE OF A CONSTANT ELECTRIC FIELD. See Abstr. 7596

8304 THERMODYNAMICS OF THERMALLY REGENERATED FUEL CELLS. J.B.Friauf.
J. appl. Phys. (USA), Vol. 32, No. 4, 616-20 (April, 1961).

It is shown that $d(\theta\Delta H)/dT = 0$ is a necessary condition for the attainment of Carnot cycle efficiency, $(T_1-T_2)/T_1$, by a thermally regenerated fuel cell system in which ideal gases are reacted in a fuel cell to convert chemical to electrical energy, and are then regenerated for recycling by thermal dissocation of the product of the reaction, also assumed to be an ideal gas. In $d(\theta\Delta H)/dT$, T is the temperature, ΔH is the change in enthalpy for the reaction in the fuel cell, and θ is the degree of reaction, or the fraction of the road from zero to 100% product which is covered by the reaction when chemical equilibrium is reached. Formulae are given for calculating the theoretical efficiency. Curves show calculated efficiencies for hypothetical thermodynamic data chosen to illustrate the effect of thermodynamic properties on efficiency. Temperature—entropy diagrams are used to explain why the efficiency reaches a maximum and then decreases when T_2 is held constant and T_1 is increased. The efficiency is pressure independent when the reaction does not involve change in the number of molecules, pressure dependent when it does.

IONIZATION

8305 ON THE THEORY OF PRIMARY SPECIFIC IONIZATION IN HELIUM. R.T.Van de Walle and C.C.Grosjean.
Nuovo Cimento (Italy), Vol. 19, No. 5, 872-902 (March 1, 1961).

This paper aims at establishing an improved formula for the non-relativistic primary specific ionization of electrons in helium, as a result of a carefully developed theory in which numerically computed helium wave-functions are introduced instead of less accurate hydrogenic wave-functions. Sect. (1) presents the calculation of the differential cross-section for inelastic scattering of an incident electron by a helium atom on the basis of a well-known method for treating rearrangement collisions which makes use of the Born approximation. In Sect. (2), the resulting formula is applied to the specific problem under consideration and it is first shown that the terms due to spin-exchange effects can be neglected under the prevailing conditions of validity. The various parts of the remaining simplified formula for the differential cross-section are then calculated explicitly and in Sect. (3), the necessary summations and integrations which ultimately lead to the primary specific ionization $S(\beta)$, are carried out. One of these integrations is studied in particular detail since it necessitates the introduction of additional simplifying approximations. The new final result for $S(\beta)$ is discussed and compared with a frequently adopted formula derived from the classical work of Bethe on primary specific ionization. A graphical representation also permits a comparison with some experimental data. The main conclusion is that the new formula is able to account for as much as 25% of the discrepancy between Bethe's formula and the experimental points. The remaining deviation can be physically understood. Finally, Sect. (4) is devoted to the velocity distributions of the secondary electrons ejected from the helium atoms during the process of primary ionization in various quantum states of angular momentum characterized by the non-negative integer l. The general behaviour of the cross-sections per unit κ-interval (κ being a convenient dimensionless velocity parameter) corresponding to $l = 0$, 1 and 2 discussed and physically interpreted. These cross-sections are also compared with their respective analytic counterparts in which Coulomb wave-functions are used to describe the final states of the ejected electrons approximately. It turns out that the agreement is excellent for $l = 2$ as well as for all higher l-values.

8306 IONIZATION IN ARGON MIXTURES BY ELECTRONS I AN ELECTRIC FIELD. M.Yamane.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1076-86 (June, 1960).

Investigation was made on ionization in a convergent field. Total filling pressure was 760 mmHg and the added impurities wer organic vapours and inert gases. The ionization current increases by the addition of these impurities even when their ionization poten tials are higher than the metastable potential of argon. The increa in ionization seems to become more remarkable as the ionization potential of the impurity lowers, and the optimum concentration that gives a maximum ionization decreases with the effectiveness of the added impurities. From the results, the possibility of direc impact ionization and photoelectric ionization is suggested.

MICROWAVE DETERMINATION OF ELECTRON CONCENTRA TIONS IN FLAME GASES. See Abstr. 8234

8307 MASS SPECTROMETER INVESTIGATION OF IONIZA TION OF N_2O BY ELECTRON IMPACT.
R.K.Curran and R.E.Fox.
J. chem. Phys. (USA), Vol. 34, No. 5, 1590-4 (May, 1961).

The N_2O molecule was studied with a nearly monoenergetic electron beam. A result of the positive ion data is a value for $D(N_2-O) \leq 1.34 \pm 0.2$ eV and a value of $D(N-NO) \leq 4.50 + 0.10$ eV Measurements were made of the kinetic energies of the ions forme N^+ and N_2^+ are found to have zero kinetic energy at threshold. The production of an O^- ion is observed with an appearance potential in the range 0 to 0.05 eV.

8308 STUDY OF THE N_2O MOLECULE USING ELECTRON BEAMS. G.J.Schulz.
J. chem. Phys. (USA), Vol. 34, No. 5, 1778-81 (May, 1961).

Inelastic processes and negative ion formation in N_2O were measured using the trapped-electron method and conventional techniques, respectively. A large inelastic process was observed at 2.2 eV and is interpreted as the formation of vibrationally excited N_2O via the formation of a temporary negative ion state. Negative ions O^- were observed beginning at zero eV with peaks o the negative ion current occurring at 0.7 and 2.2 eV. The latter peak is attributed to the formation of the temporary negative ion w subsequent decay into a stable O^- plus N_2 in various states of vibrational excitation. Measurements of the kinetic energy of the negative ions confirmed this hypothesis. A value of the dissociatio energy of the N_2-O bond in N_2O was found from the appearance potential of O^- extrapolated to zero kinetic energy. This value, $D(N_2-O) = 1.2 \pm 0.2$ eV, agrees within experimental error with the value of 1.3 ± 0.2 found independently by Curran and Fox, but disagrees with the thermochemical value of 1.66 eV.

8309 IONIZATION PROCESSES IN CCl_4 AND SF_6 BY ELECTRON BEAMS. R.E.Fox and R.K.Curran.
J. chem. Phys. (USA), Vol. 34, No. 5, 1595-1601 (May, 1961).

The ionization processes in CCl_4 and SF_6 were studied for both positive and negative ions in a mass spectrometer, and in a total ionization tube. The appearance potential of Cl^- is 0 + 0.05 eV wit a very sharp energy dependence. A second process with an onset a about 0.4 eV and a maximum at about 0.7 eV, exhibits a much broa energy dependence. The relative intensities of these two processe are found to be extremely sensitive to the energy distribution of th electron beam, but do not appear to exhibit a temperature depende From the appearence potentials and kinetic energy measurements Cl^- a value of 3.30 ± 0.07 eV is obtained for $D(CCl-Cl)$. The appearance potential curves for CCl_3^+ and SF_5^+ near threshold indi cate structure which may be associated with energy states of these ions.

8310 ALPHA-PARTICLE IONIZATION IN POLYATOMIC GASES AND THE ENERGY DEPENDENCE OF W.
W.P.Jesse.
Phys. Rev. (USA), Vol. 122, No. 4, 1195-202 (May 15, 1961).

An extended series of measurements was made by three diffe ent methods to determine the variation of W, the average energy to make an ion pair, in the gases N_2 and C_2H_4 as a function of the energy of the ionizing alpha particle. In one method, the ionizatio ratios were determined in the two gases for single alpha particles from two collimated polonium sources, the particles from one source being reduced in energy by passage through a succession o interchangeable mica windows. The corresponding energy ratios were determined by auxiliary measurements in pure argon, the W values in argon being assumed constant. W values for alphas of initial energy up to 9 MeV were also obtained by a comparison in

$_2H_4$ and N_2 of the relative ionization from Po and ThC' single alpha articles. Data from all these experiments indicate a continuous ecrease in W values in C_2H_4 and N_2 with increasing alpha energy ver a range from 1-9 MeV. The differential w (defined as the ratio energy increment ΔE to ionization increment ΔI at any point on e alpha path) also decreases similarly and seems to approach ut never quite reach, within the limits of alpha energy investigated, e corresponding W value for beta particles. No explanation of is continuous decrease with energy of the W values can at present e advanced.

8311 THE STATISTICS OF ELECTRON AVALANCHES IN ELECTRO-NEGATIVE GASES, AT HIGH FIELD NTENSITIES AND AT LARGE GAS AMPLIFICATION. W.Legler. . Naturforsch. (Germany), Vol. 16a, No. 3, 253-61 (March, 1961). n German.

The statistical distribution of the carrier number of single lectron avalanches in a Townsend discharge is described by (n) = $1/\bar{n}\cdot\exp(-n/\bar{n})$ if one introduces some simplifying assumptions. hese assumptions are violated in the following cases: electro- egative gases, strong electric fields, and large gas-amplification. n electronegative gases, only a part of the primary electrons form bservable electron avalanches. These are still subject to an xponential distribution but with an increased mean value. In strong lectric fields, the ionization probability depends on the previous istory of the individual electrons. This leads to a distribution ith a marked maximum and a reduced dispersion. In a first pproximation, the form of the distribution is determined by E/α:U_i. n the case of large gas-amplification, the further development of e avalanche is influenced by the space charge and one gets a odified exponential distribution. The calculated distributions agree ell with the experiments of other authors.

8312 THE GENERAL THEORY OF THE MOTIONS OF IONS AND ELECTRONS IN GASES. L.G.H.Huxley. ustral. J. Phys., Vol. 13, No. 4, 718-37 (Dec., 1960).

In this paper the more important general formulae for the drift elocities and diffusion coefficients of ions and electrons in gases re derived by the application of dynamical principles. These rmulae agree with those already established by a proper appli- ation of the method of free paths. Formulae for the distribution f speeds of agitation are also derived.

8313 ION–NEUTRAL REACTIONS IN THE HELIUM–HYDROGEN SYSTEM. I.Hertzberg, D.Rapp, I.B.Ortenburger and D.D.Briglia. . chem. Phys. (USA), Vol. 34, No. 1, 343-4 (Jan., 1961).

Three secondary reactions of the helium–hydrogen system are onsidered and values deduced for the relative rates of reaction and e reaction energies. G.I.W.Llewelyn

ELECTRIC DISCHARGES

8314 NEGATIVE STRIATIONS. J.R.M.Coulter. hysica (Netherlands), Vol. 26, No. 11, 949-53 (Nov., 1960).

Striations of high velocity and small luminosity, travelling owards the anode, were studied in some neon discharges with otating mirror and photomultiplier techniques. These "negative" aves seem to be associated with a frequency multiplication of ositive striations, which occurs near the head of the positive olumn. They are not usually observed at the anode. It would ppear that fluctuations in tube voltage, rather than negative triations, effect synchronization between anode spot oscillations nd positive striations.

8315 FORMATION OF CATHODE SPOTS AND CURRENT DENSITY DISTRIBUTION IN CATHODE SPOTS OF HORT-TIME HIGH-INTENSITY ELECTRIC DISCHARGE. E.Žižka. zech. J. Phys., Vol. 10, No. 4, 327-33 (1960). In Russian.

The connection between the current density distribution in a pot and the vapour jets was found for a short-time high-intensity lectric discharge by studying the structure of partial cathode traces nd measuring the current density on the cathode. The variation of he current density on the spot with the current gradient was also ound and the etching of the cathode surface with ionic bombard- ient at a pressure of 760 mm Hg was observed.

THE DISTRIBUTION OF INTENSITY OF NEUTRON RADIATION ALONG THE AXIS OF A STRAIGHT TUBE DURING A STRONG PULSED DISCHARGE IN DEUTERIUM. See Abstr. 7246

8316 ELECTRICAL BREAKDOWN OF GASES AT PRESSURES CLOSE TO ATMOSPHERIC PRESSURE. I.S.Marshak. Uspekhi fiz. Nauk (USSR), Vol. 71, No. 4, 631-75 (Aug., 1960). In Russian.

The author distinguishes five types of breakdown but reviews mainly the type which occurs at voltages only slightly above the static breakdown voltage for not too long spark gaps and at pressures above 20 mm Hg. The article includes an extensive bibliography on this subject. It is pointed out that this form of breakdown has been explained principally in terms of a Townsend mechanism or streamer development. The author gives ten criteria for determining the correct theory and which may be compared with known experimental data: (1) the fundamental equation; (2) calculated and experimental values of breakdown voltage; (3) dispersion of breakdown values; (4) dependence of breakdown value on cathode material; (5) dependence of breakdown on external radiation; (6) time of formation of breakdown; (7) increase in current in first stages of breakdown; (8) early luminescence characteristics; (9) existence of glow discharges; (10) spatial structure. For all the criteria, the author concludes that the Townsend mechanism is a more favourable explanation of the breakdown when the overvoltage is only small, but that a streamer mechanism probably holds at higher voltages. A separate section is given on breakdown produced by an auxiliary high-voltage discharge. A theory is given describing the breakdown in terms of the energy balance in the discharge column and experiments are described which indicate the validity of the theory. [English translation in Soviet Physics–Uspekhi (USA), Vol. 3, No. 4, 624-51 (Jan.-Feb., 1961)]. H.Edels

8317 BREAKDOWN OF ARGON AT LOW PRESSURE IN A LONGITUDINAL MAGNETIC FIELD. K.Mitani and H.Kubo. J. Phys. Soc. Japan, Vol. 15, No. 4, 678-84 (April, 1960).

The breakdown probability was measured over the range from 0 to 1 500 gauss of the magnetic field parallel to the electric field. With overvoltage fixed at 16.5%, the number of breakdown times was counted for the applied square pulses with an electronic counter. The breakdown probability was found to increase with magnetic field intensity. It was calculated on the assumption that breakdown was caused by multi-avalanche, and the secondary mechanism was due to the drift of resonance radiation in the diffusion process as Kachikas and Fisher have suggested. A fairly good agreement between theory and experiment was attained and the drift velocity of resonance radiation was about 9.5×10^5cm. sec^{-1} in the calculation.

8318 OPTIMUM CONDITIONS TO OBSERVE THE NEW LIGHT EFFECT. P.S.V.Setty. Indian J. Phys. Vol. 34, No. 4, 187-95 (April, 1960).

Experiments with electrodeless discharge tubes containing iodine vapour were conducted with special reference to ageing. The results show that the effect of ageing is only the removal of occluded gases and vapours from the glass wall of the discharge tube. As a consequence of these experiments a new apparatus called the "envelope tube" was devised to obtain consistent results without waiting for ageing. From these results the optimum conditions for observing the new light effect have been worked out to be (a) ageing the envelope tube under low external pressure or heating it to a high temperature in vacuum till standard current voltage characteristics as shown are obtained; (b) sealing it under the above condition. The cleaning up procedure recommended refers only to the external surface of the discharge tube.

PLASMA

(See also Magnetohydrodynamics)

8319 ION–ELECTRON RELAXATION OF PLASMAS IN A MAGNETIC FIELD. II. T.Kihara, Y.Midzuno, K.Sakuma and T.Shizume. J. Phys. Soc. Japan, Vol. 15, No. 4, 684-7 (April, 1960).

For Pt I see Abstr. 294 of 1961. Relaxation between ion and electron temperatures, T_1 and T_2, of dilute fully ionized gases in a magnetic field was treated by force-correlation method. The rate

R of the relaxation, defined by

$$d(T_2 - T_1)/dt = -(T_2 - T_1)R,$$

increases with increasing magnetic field from

$$R = R^0 \ln(t_p/t_s) \quad \text{for } \omega_2 t_p < \sim 1$$

to $$R = R^0[\ln(t_p/t_s) + \tfrac{1}{2}(\ln \omega_2 t_p)^2] \quad \text{for } \omega_2 t_p \gg 1,$$

in which

$$R^0 = (n_1 + n_2)(8m_2/3m_1)(2\pi kT_2/m_2)^{1/2}(Ze^2/kT_2)^2.$$

Here m_1, Ze and n_1 are the mass, charge and number density of the ion repsectively; m_2, $-e$, and n_2 are those of the electron; t_p is the period of plasma oscillation and t_s is the mean time of passage through a sphere of strong interaction, $t_s \sim (m_2/kT_2)^{1/2}Ze^2/kT_2$; ω_2 is the electron gyration frequency.

8320 PROPOSED DIAGNOSTIC METHOD FOR CYLINDRICAL PLASMAS. J.Shmoys.

J. appl. Phys. (USA), Vol. 32, No. 4, 689-95 (April, 1961).

For a cylindrically symmetric plasma column whose electron density N is a slowly varying monotonically decreasing function of radius r, it is possible to calculate explicitly both the electromagnetic-wave diffraction pattern from a knowledge of N(r) and, conversely, N(r) from a knowledge of the diffraction pattern. If the diffraction pattern is obtained experimentally, N(r) can be calculated by a cumbersome numerical procedure. Instead of doing this, the diffraction pattern can be approximated by one of a family of convenient analytical expressions for which the integration can be carried out easily. Alternatively, one can attempt to infer N(r) by assuming a functional form for N(r) with one or more parameters, calculating the diffraction pattern, and comparing it with the observed one.

8321 STUDY OF RETURN TO EQUILIBRIUM OF A PARTICLE IN A PLASMA. (FOKKER–PLANCK EQUATION). J.Salmon.

J. Phys. Radium (France), Vol. 21, No. 10, 699-706 (Oct., 1960). In French.

Studies the possibility of interpreting the return of the test particle to Maxwellian distribution, using the development which is obtained, and discusses the validity limits of the Rosenbluth, MacDonald and Judd approximation (Abstr. 8642 of 1957).

8322 LOSSES THROUGH BREMSSTRAHLUNG IN RELATIVISTIC AND ULTRA-RELATIVISTIC REGION OF ELECTRON TEMPERATURES OF PLASMA. J.Kvasnica.

Czech. J. Phys., Vol. 10, No. 4, 261-7 (1960).

The losses through bremsstrahlung in a sufficiently diluted hydrogen plasma (plasma with infinitely large Debye–Hückel radius) are calculated for the relativistic ($kT <\sim mc^2$) and ultra-relativistic ($kT \gg mc^2$) region of electron temperatures (m is the rest mass of the electron). In the ultra-relativistic temperature region the amount of energy I(tot) emitted by 1 cm^3 of plasma per sec as a result of electron–ion and electron–electron collisions is given by

$$I(tot) = 3.39 \times 10^{-29}(n^2/\mu)[1.86 + E_1(\mu)]\ \text{watt cm}^{-3}$$

where n is the density of the ions (or electrons), $\mu = kT/mc^2$ and

$$E_1(\mu) = \int_{\mu}^{\infty} x^{-1} \exp(-x)\, dx$$

is the integral exponent. The results are suitable for a plasma of density $n \ll 10^{30}\ cm^{-3}$.

8323 CYCLOTRON EMISSION FROM PLASMAS WITH NON-MAXWELLIAN DISTRIBUTIONS.

G.Bekefi, J.L.Hirshfield and S.C.Brown.

Phys. Rev. (USA), Vol. 122, No. 4, 1037-42 (May 15, 1961).

Cyclotron emission from high-energy plasmas is calculated for two classes of electron distribution functions: (a) those that decrease monotonically with increasing electron energy, and (b) those than have one or more maxima displaced from zero energy. In (a) the emission does not differ greatly compared with the emission from a Maxwellian plasma of the same energy. In (b) the emission can grow exponentially with distance traversed in the plasma, resulting in a greatly enhanced loss of radiant power.

8324 GENERATION AND MEASUREMENT OF HIGHLY IONIZED QUIESCENT PLASMAS IN STEADY STATE.

R.C.Knechtli and J.Y.Wada.

Phys. Rev. Letters (USA), Vol. 6, No. 5, 215-17 (March 1, 1961).

A stable, cold caesium plasma was generated in a magnetic field. The validity of measuring plasma temperature and density by means of double probes in a magnetic field was confirmed by comparison with pyrometer and microwave measurements. From the profile of the column, preliminary results indicate that the diffusion across the field is ambipolar. The plasma was more than 90% ionized to densities greater than 10^{12} ions cm^{-3}. The recombination coefficient $\alpha < 10^{-10}\ cm^3\ sec^{-1}$, somewhat lower than the accepted value. J.W.Sturge

8325 TRANSPORT PROPERTIES OF PLASMAS IN A STRONG MAGNETIC FIELD. T.Kihara, Y.Midzuno and S.Kaneko

J. Phys. Soc. Japan, Vol. 15, No. 6, 1101-7 (June, 1960).

Irreversible processes in plasmas in a strong magnetic field are discussed from both phenomenological and microscopic points of view. The thermodynamics of irreversible processes is applied and it is shown that the Onsager–Casimir reciprocity relation takes a symmetrical form for plasmas in a magnetic field. For a two-component fully ionized gas where the electrons make many free gyrations interference between electrical and thermal conductions vanish. When the mean gyration radius r_g of the electrons is shorter than the Debye length l_D, the diagonal elements of tensors of the electric conductivity and diffusion coefficient perpendicular to the magnetic field are proportional to

$$\ln(kT l_D/Ze^2) + (3/4)[\ln(l_D/r_g)]^2,$$

where Ze and $-e$ are the charges of an ion and electron respectively.

8326 THE DEPENDENCE OF THE PLASMA CONDUCTIVITY ON FREQUENCY AND COLLISION TIME.

O.Theimer and L.S.Taylor.

Ann. Phys. (USA), Vol. 11, No. 3, 377-92 (Nov., 1960).

The drift velocity $\bar{\rho}(T)$ (T = time) of electrons in a plasma exposed to an radiation external field E(T) is calculated by a method which takes the finite duration of encounters between charged particles explicitly into account. Orbits of electrons passing through the nearest neighbour zone of an ion and exposed to the field of that ion and to the radiation field are computed as function of the collision parameter p, the gas kinetic velocity v, and the time of closest approach between electron and ion, T_0. $\bar{\rho}(T)$ is obtained as an average over the stochastic variables p, v, T_0, and is found to satisfy the equation $m[d\bar{\rho}(T)/dT] = -\epsilon E(T) - m\nu_C(\omega)\bar{\rho}(T)$. m and $-\epsilon$ are the electron mass and charge, respectively. The coefficient of dynamic friction $m\nu_C(\omega)$ is a function of the radiation frequency ν_0 of the form

$$m\nu_C(\omega) = m\nu_C[1 + (2\pi^{2/3}i\nu_0 d/v)(1 - 3.35/\log d/\pi^{1/3}p_0) - 0.835(2\pi^{2/3}\nu_0 d/v)^2 + \cdots],$$

where ν_C is the conventional collision frequency, P_m the average distance between neighbouring ions, and p_0 the collision parameter corresponding to 90^0 deflection.

8327 PULSE CONDUCTION IN DECAYING PLASMA. V.Arunasalam and J.D.Trimmer.

Rev. sci. Instrum. (USA), Vol. 32, No. 3, 282-5 (March, 1961).

Apparatus was constructed in which plasma, ionized by 144 Mc/s r.f. excitation, was subjected to repeated submicrosecond voltage pulses immediately after removal of excitation. It is expected that observed variation of resulting current pulses may be correlated with quantitative aspects of the plasma decay.

8328 CONCERNING CERTAIN COLLISIONLESS PLASMA-SHOCK WAVE MODELS. P.D.Noerdlinger.

Astrophys. J. (USA), Vol. 133, No. 3, 1034-42 (May, 1961).

A shock-wave model proposed by both Kahn and Parker for the collision of two interstellar gas clouds or of the solar wind with the ionized gas around the earth is re-evaluated in the light of recent developments in plasma stability theory. It is shown that the instability which was supposed to arrest the counterstreaming of the ions and to transfer much of their kinetic energy to the electrons does not occur in many important examples. Specifically, it is absent if the initial ion thermal energy exceeds 4.2×10^{-4} times their translational energy. While other plausible shock structures are known which yield suprathermal electrons, they depend on magnetic fields, leaving no satisfactory theory in the limit of zero magnetic field.

8329 THEORY OF THE "RESTORING" LAYER. V.N.Zhigulev.

Dokl. Akad. Nauk SSSR, Vol. 134, No. 5, 1313-16 (Oct. 21, 1960). Russian.

For abstract, see Abstr. 5444 of 1961. [English translation in: Soviet Physics–Doklady (USA), Vol. 5, No. 5, 969-72 (March-April, 1961)].

8330 THE FLUCTUATING MICROFIELD AND THE MULTIPLE COLLISIONS IN A GAS OF CHARGED (OR GRAVITATING) PARTICLES. V.I.Kogan.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 6, 1374-7 (Dec. 21, 1960). In Russian.

An argument is given showing certain previous approaches to the subject to be erroneous. For a sufficiently general case the mean square of the increase in a time interval Δt of the transverse linear momentum of a test particle in a gas of field particles is calculated. The result is finite without any artificial cut-off. It is shown that taking into account the collective influence of many particles on the test particle does not change the "binary" character of the scattering formulae. [English translation in: Soviet Physics–Doklady (USA)]. F.Herbut

8331 RELATIVISTIC ASPECTS OF THE PHENOMENON OF STRICTION (THE PINCH EFFECT). T.T.Vescan.
Stud. Cercetari stiint. Fiz. Stiint tehn. (Roumania), Vol. 11, No. 1, 7-12 (1960). In Roumanian.

The acceleration of a free particle in a static axi-symmetric space–time of a certain type is determined from the Euler–Lagrange equations of geodesics. Proposed application: study of the axi-symmetric motion of a plasma. F.A.E.Pirani

8332 ESTIMATION OF THE MAXIMUM TEMPERATURE IN A RADIALLY CONSTRICTED GAS DISCHARGE BETWEEN ELECTRODES. P.W.Seymour.
Austral. J. Phys., Vol. 14, No. 1, 129-51 (March, 1961).

A steady-state deuterium discharge between two electrodes is considered and the free boundary surface of the plasma is assumed thermally insulated when pinched away from the walls of the discharge tube. Cooling is therefore by heat conduction to the electrodes, compared to which bremsstrahlung loss is shown to be negligible if the discharge is not too long. The main question examined is how much the maximum temperature T_m can be raised by constricting the cross-section of the discharge near the centre. The analysis is confined to substantially ionized deuterium, and curves based on the Saha equation are provided to show the minimum gas temperatures required for various particle densities. With neglect of thermoelectric effects, there exists a median plane, normal to the longitudinal axis of the discharge, about which the distributions of temperature and voltage are symmetrical. The analysis is carried through both by specializing the current density and heat flux vectors, j and q, to cater for an isotropic plasma, and for a plasma made anisotropic by a strong, external magnetic field. Prior to detailed mathematical analyses, however, a simple continuity argument yields the important relationship, $q + Vj = 0$, where V is the electric potential, provided that everywhere within the discharge q is parallel to j. This type of flow, termed for convenience longitudinal flow, is the main concern of the paper. The detailed axi-symmetric analyses for slightly and greatly constricted discharges show that $T^2 + (\sigma_0/K_0)V^2 = T_m^2$, where σ_0 and K_0 are related to Spitzer's formulae for the electrical and thermal conductivities of a highly ionized gas [Spitzer, L., Jr. Physics of Fully Ionized Gases. New York: Interscience Publishers (1956), pp. 67, 72], and T_m is the temperature on the median plane, where $V = 0$. Use of an electric stream function Ψ and the electric potential V as curvilinear coordinates simplifies the plasma energy equation. An analytic solution of this equation if the temperature T is a function of Ψ only, shows that the heat flow can be everywhere perpendicular to the flow of electricity only when the streamlines are straight and parallel to the longitudinal axis of symmetry. Analytic solutions if T is a function of V, representing the longitudinal flow, are given for (1) straight streamlines parallel to the longitudinal axis of symmetry, (2) hyperbolic streamlines to represent a discharge constricted at the median plane. A curve giving the variation of T with distance along the linear discharge is included. Upper-limit expressions for the central temperature T_m are obtained in terms of the total current carried by the longitudinally stabilized discharge and its characteristic dimensions, and a curve gives the dependence on constrictions of T_m and of the resistance R between the electrodes for constant total discharge current. If a large radial constriction at the median plane is achieved by use of a strong guiding magnetic field which makes the conductivities anisotropic, a tensorial analysis is required, but leads to the same results for longitudinal flow. Where the thermal insulation and neglect of bremsstrahlung approximations apply, the direction of heat flow is not expected to depart significantly anywhere from that of the flow of electricity, and so the above curve should provide a useful guide to the increase of T_m and R due to constriction. For an area constriction of 400 : 1, T_m and R are increased by a factor of about 4. Characteristics relating T and the magnetic field H, when $\omega_e\tau_e = 1$ (ω_e is the electron gyrofrequency, τ_e the electron collision time) are given for various values of the total particle density. Hence it is possible to find where the vector ($\omega_e\tau_e \ll 1$) and tensor ($\omega_e\tau_e \gg 1$) solutions are applicable.

8333 FORMATION OF A PLASMA BY LOW ENERGY ION INJECTION AND CYCLOTRON HEATING. T.Dodo.
J. Phys. Soc. Japan, Vol. 15, No. 5, 906-15 (May, 1960).

A new method was devised to produce a high temperature plasma by injecting an ion beam into a static magnetic mirror field. In this method, ions are injected along the axis of the d.c. magnetic field lines and are given energy through the oscillating e.m. field of the cyclotron frequency. Therefore, the magnetic moments of ions are increased while they travel from one end of the mirror field to the other end. The injected ions are thus reflected at the opposite mirror end and some of them perform reciprocating motions between both ends. While an in-phase ion gets energy from the r.f. field, an out-of-phase ion is decelerated and escapes from the mirror ends. The probability of trapping an injected ion is about three-tenths to one-half, depending on the strength of the oscillating field. As the ion current becomes large, which is opposite phase to the external r.f. current, the injected ions are no longer trapped. The ion density will be limited to about $10^{12}/cm^3$.

8334 ON THE AMPLIFICATION OF THE POLOIDAL MAGNETIC FLUX IN A PLASMA.
L.Lindberg and C.Jacobsen.
Astrophys. J. (USA), Vol. 133, No. 3, 1043-8 (May, 1961).

An experiment is described by which a magnetized plasma is produced. The plasma has both a toroidal and a poloidal magnetic field. Under certain conditions the current system in the plasma becomes unstable, and part of the toroidal field is converted to a poloidal field. In this way the poloidal flux becomes amplified up to three to five times the original value. This phenomenon may be related to the mechanism by which the earth and other celestial bodies are magnetized.

8335 ON THE ORIGIN OF COSMIC MAGNETIC FIELDS. H.Alfvén.
Astrophys. J. (USA), Vol. 133, No. 3, 1049-54 (May, 1961).

As an alternative to the "self-exciting dynamo", a non-stationary model is discussed. The model is based on an effect which Lindberg discovered in a plasma experiment. The suggested mechanism is the following: In an original poloidal field, hydrodynamic motion produces a toroidal field. When this has reached a certain strength, it becomes unstable. A kink instability changes the field configuration in such a way that an amplified poloidal magnetic field is produced. The process is then repeated. In order to start the field amplification, a very simple pattern of motion is needed, which may easily be produced both in the interior of planets and stars and in interstellar matter.

Plasma Oscillations

8336 ON PLASMA OSCILLATIONS WITH SPECIAL EMPHASIS ON THE LANDAU DAMPING AND THE GROSS GAPS IN THE FREQUENCY SPECTRUM. A.Kildal.
Nuovo Cimento (Italy), Vol. 20, No. 1, 104-22 (April 1, 1961).

A linear theory of oscillations of the form $\exp[i(\vec{k}\cdot\vec{r}-\omega t)]$ in a collision-free electron plasma in an external magnetic field $\vec{H}_0$ is given. The theory is based on the equations of motion for each particle. Only the case $\vec{k} \to 0$ is studied and the singularities which then appear, are treated with the use of δ-functions. Expressions for the perturbation $\delta\vec{v}$ of the electron velocity are found. By a Taylor expansion in $\delta\vec{v}$ the perturbation of the distribution function is evaluated and the density perturbation N_1 as well. The last quantity also satisfies the divergence equation. On elimination, a dispersion equation is obtained. In the case $k \cdot H_0$, electrons with velocity equal to the phase velocity experience a constant electric field. Being thus accelerated, they deprive the field of its energy. This resonance absorption is calculated and the accompanying damping agrees with the Landau damping. The frequency gaps which appear in the case $\vec{k}\ \vec{H}_0 = 0$ are then studied.

8337 NON-LINEAR EFFECTS ON ELECTRON-PLASMA OSCILLATIONS. M.Sumi.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1086-93 (June, 1960).

A nonlinear term in the Boltzmann equation is considered as a perturbation. With the growth of the fundamental component, the second and the higher harmonics are generated as forced oscillations. The magnitudes of these components are estimated which give the criteria of validity of linear approximation. Finally the behaviours of excited waves in the limit of large amplitude are described.

8338 OSCILLATIONS IN A PLASMA IN A WEAK MAGNETIC FIELD. K.Kato.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1093-101 (June, 1960).

The oscillations in a bounded plasma in an external magnetic field were studied. The hot cathode discharge tubes used were filled with mercury vapour at pressure of the order of 10^{-3} mm Hg. The weak uniform magnetic field whose strength was in a region between 0 and 350 gauss was applied parallel to the direction of discharge current. The oscillations were detected by a super-regenerative detector adjusted to a constant frequency. The oscillations of two types were detected: One has a frequency which depends on the magnetic field strength alone, and the other has a frequency which depends on the magnetic field strength alone, and the other has a frequency which depends on the electron concentration as well as the magnetic field strength. The former is interpreted as the cyclotron resonance oscillation, and the latter as the plasma type oscillation.

8339 THE GENERATION OF PLASMA WAVES IN STRONGLY IONIZED GASES. H.Gerstenkorn.
Z. Phys. (Germany), Vol. 162, No. 4, 363-81 (1961). In German.

Considers the growth of plane waves in a plasma without external fields. The Boltzmann equation is discussed and solved explicitly for the case with initial conditions (Anfangswertproblem). With the usual expression for the collision term, no eigensolutions exist. Nevertheless, in a short time long waves develop with $\lambda > 30 l_D$ (Debye length) from the initial distribution; the statistical damping cancels out the development of shorter waves. Changing the collision term, one finds true eigensolutions. This different behaviour of the solutions seems to be less a physical problem than a question of the mathematical formalism used.

ELECTRON EMISSION
ELECTRON BEAMS

8340 TEMPERATURE DEPENDENCE OF THE WORK FUNCTION OF METALS (Mo,Ni).
G.Comsa, A.Gelberg and B.Iosifescu.
Phys. Rev. (USA), Vol. 122, No. 4, 1091-1100 (May 15, 1961).

The temperature coefficient of the work function (TCWF) of polycrystalline Mo and Ni was measured in the temperature ranges 600-1100°K and 475-1025°K, respectively, using the electron beam method. Special precautions were taken in order to avoid systematic errors due to the effect of residual gases, of stray magnetic fields, of incorrect temperature measurement, of cathode temperature variations, etc. During determinations made upon Ni surfaces the terrestrial magnetic field was compensated. Random error sources were likewise reduced as much as possible. The main results obtained on surfaces outgassed for many thousands of hours at pressures of $1\text{-}3 \times 10^{-9}$ torr are

$$\left\langle \left(\frac{d\Psi_{Mo}}{dT} \right) \right\rangle_{av} = (7.84 \pm 0.07) \times 10^{-5} \text{ eV/°K},$$

$$\left\langle \left(\frac{d\Psi_{Ni}}{dT} \right)_{T > \theta \text{ Curie}} \right\rangle_{av} = (-3.12 \pm 0.05) \times 10^{-5} \text{ eV/°K}.$$

At the Curie point of Ni a theoretically expected variation of the TCWF was observed:

$$\left\langle \left(\frac{d\Psi_{Ni}}{dT} \right)_{T < \theta} - \left(\frac{d\Psi_{Ni}}{dT} \right)_{T > \theta} \right\rangle_{av} = (-0.90 \pm 0.17) \times 10^{-5} \text{ eV/°K}$$

but no jump of the work function was found at this point. Special experiments showed that the results were not significantly affected by residual gases. A relation between the TCWF measured on poly crystalline surfaces of Ni and the TCWF of the various facets of th surfaces was obtained.

8341 EXPERIMENTAL EVIDENCE FOR THE EXISTENCE OF TWO DISTINCT FIELD EMISSION CHARACTERISTICS FROM SILICON EMITTERS. R.L.Perry.
J. appl. Phys. (USA), Vol. 32, No. 1, 128-30 (Jan., 1961).

Data obtained from a field emission projection microscope is used to plot graphs of field-emitted current against applied voltag for various clean silicon surfaces. Two distinct types of characte istic were found. One type was similar to that found for metallic emitters and it was suggested that the silicon specimens were degenerately p-type at the tip, whereas for the other type of charac teristic the silicon was not degenerate and the energy bands may have been free to bend under the high electric fields.
W.G.Townsen

8342 FIELD EMISSION FROM WHISKERS.
A.J.Melmed and R.Gomer.
J. chem Phys. (USA), Vol. 34, No. 5, 1802-12 (May, 1961).

A method for obtaining field emission from whiskers grown in situ from the vapour under high-vacuum conditions had been devel and is described. It is possible to fabricate clean and strong emit from almost any conducting material, so that the range of substan that can be used for field emission has been considerably expande Electrical methods for following the growth kinetics and determining whisker length and radius are described and applied to Au. Growth is found to be positively exponential with time, which supports a mechanism of growth by diffusion of impinging atoms over the whisker sides and incorporation at the growing end. Cessation of growth is diffusion limited in these experiments. It was possible to estimate the activation energy for the surface diffusion of Au on Au as 23 ± 5 kcal from the variation of termina length with temperature. Some adsorption and oxidation experime indicate that the method can also be used for the study of these phenomena. It was found for instance that H_2 is not adsorbed on A and that Al is oxidized with severe surface rearrangement even at 77°K.

ELECTRON-EMISSION MICROSCOPE AND VELOCITY DISTRIBUTION STUDIES ON SILICON CARBIDE P–N JUNCTION EMITTERS. See Abstr. 7658

8343 SOME EXPERIMENTS ON THE FATIGUE AND TEMPERATURE DEPENDENCE OF PHOTOELEMENT
E.Helbig and H.Klaus.
Jenaer Jahrbuch (Germany), 1959 II, 441-73. In German.

The fatigue effects of two selenium barrier-layer photocells are investigated as functions of intensity of illumination, tempera ture, the external resistance, and the spectral distribution of the light. The variation of photocurrent with the same parameters is also described. C.A.Hoga

8344 EXO-ELECTRON EMISSION FROM IONIC CRYSTALS
W.Hanle, G.Kanzler and A.Scharmann.
Z. Phys. (Germany), Vol. 162, No. 5, 483-8 (1961). In German

The emission of electrons from NaCl, LiF and ZnS crystals after excitation by electrons and α-particles was investigated. T influence of external electrical fields on the emission was studied The results of this investigation are compatible with the model developed by Matyas [Czech. J. Phys., Vol. 7, 277 (1957)], according to which an electrical dipole-layer is caused by the distribution of lattice defects in the surface.

8345 ELECTRON YIELD IN THE CASE OF LITHIUM-ION BOMBARDMENT OF IMAGE CONVERTOR SURFACES
H.Seiler.
Z. Phys. (Germany), Vol. 163, No. 1, 56-61 (1961). In German.

The electron yield in the case of bombardment of a stainless steel plate (type V2A) by Li^+ ions with energies between 20 and 80 keV was measured. The yield increases from 2.5 electrons pe ion for 20 keV to 4 for 70 keV. The electron yield in case of trans mission by Li^+ ions (number of electrons emitted on the back side of the foil per incident ion) of thin carbon foils with a layer of evaporated silver was measured. For this purpose the electrons emitted on the back side of foil were accelerated in an immersion objective lens, and the resulting crossover of the beam was focused into a Faraday cage by a projector lens. The electron yield depends on the ion energy and the foil thickness. Its value

es between 1 for a 1050 A thick silver foil and 40 keV and 4 for 380 A thick silver foil and 80 keV. The range of Li^+ ions in silver an be estimated by extrapolation of the yield curves. It increases rom 600 A for 10 keV to 2300 A for 80 keV. The electron yield ay not be characteristic for the target material since in a vacuum f 10^{-4} torr the formation of a thin layer of polymerized hydro- arbon on the surface must be expected.

8346 OSCILLATIONS AND SATURATION CURRENT MEASUREMENT IN THERMIONIC CONVERSION CELLS. R.J.Zollweg and M.Gottbieb.
J. appl. Phys. (USA), Vol. 32, No. 5, 890-4 (May, 1961).

Radio-frequency oscillations observed in caesium-filled hermionic diodes are interpreted on the basis of a model which assumes that the caesium ions oscillate in an excess negative charge potential well outside the cathode. A simplified theoretical treatment shows that the period at the onset of oscillations is linear with cathode-anode spacing in agreement with experiment, and relates the oscillation period to the ratio of cell current to saturation emission current. It is found that the rapid decrease of oscillation amplitude as the cell current reaches a critical value can be used to measure saturation emission currents.

8347 LOW-FREQUENCY OSCILLATIONS IN A FILAMENTARY CATHODE CESIUM DIODE CONVERTER. .P.Luke and F.E.Jamerson.
appl. Phys. (USA), Vol. 32, No. 2, 321 (Feb., 1961).

Reports low frequency oscillations, below 100 kc/s, observed Cs diodes in which the anode/cathode diameters ratios were in e range 10-45. The frequency decreased as the ratio increased id was only 5 kc/s for the largest value. A.H.W.Beck

8348 FLICKER NOISE IN TRIODES WITH POSITIVE GRID. R.C.Schwantes and A.van der Ziel.
hysica (Netherlands), Vol. 26, No. 6, 1143-56 (Dec., 1960).

The noise in positive grid triodes is represented by two noise urrent generators i_a and i_g connected between cathode and grid and etween cathode and anode, respectively. An accurate method for etermining $\overline{i_a^2}$, $\overline{i_g^2}$ and the correlation coefficient $c = \overline{i_a i_g}/[\overline{i_a^2}\,\overline{i_g^2}]^{\frac{1}{2}}$ s proposed and carried out for several 6SN7 triodes. It is found hat the noise generated at the cathode is distributed over the ositive electrodes neither as the d.c. currents nor as the a.c. urrents. The correlation coefficient c at low frequencies where licker noise predominates is positive. Its magnitude can be ccounted for by assuming that the electron beam, coming from a oisy spot on the cathode, has at the grid spread over a width omparable with or larger than the grid wire diameter; modulation f these electron beams can account for some details of the bservations. The results are compatible with what is presently nown about the flicker noise mechanisms operating in oxide-coated athodes. The part of i_a and i_g that is uncorrelated with the noise enerated at the cathode can be interpreted as a "partition flicker oise".

8349 FLICKER NOISE IN PENTODES. FLICKER PARTITION NOISE. R.C.Schwantes and A.van der Ziel.
hysica (Netherlands), Vol. 26, No. 12, 1157-61 (Dec., 1960).

The method of approach used in the study of flicker noise in ositive grid triodes is applied to pentodes with some modifications. t is demonstrated experimentally that the flicker noise current enerated at the cathode of a pentode distributes over the positive lectrodes in the ratio of the a.c. currents. Tomlinson's discovery f flicker partition noise [Abstr. 3386B of 1955; J. Brit. Instn. adio Engrs, Vol. 14, 515 (1954)] is verified and it is shown that is results are caused by a noise current generator connected etween screen grid and anode that is indeed independent of the licker noise generated at the cathode.

8350 SECONDARY EMISSION FLICKER NOISE. R.C.Schwantes and A.van der Ziel.
hysica (Netherlands), Vol. 26, No. 12, 1162-6 (Dec., 1960).

The secondary emission flicker noise observed by Schwantes, annam and van der Ziel was investigated by a new method. It was ecently found that the electron bombardment of the anode of a acuum tube could cause an enhanced generation of flicker noise at ie cathode. The earlier method of investigation of secondary mission flicker noise did not discriminate against this possibility, o that the existence of the effect was in doubt. A new method of easurement that is independent of this enhancement effect shows at the secondary emission flicker effect is real.

8351 HIGH SPEED OSCILLOSCOPE WITH ELECTRON OPTICAL MAGNIFICATION USING FOUR-POLE LENSES. A.B.El-Kareh.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 421-4 (April, 1961).

A new method of high-speed oscillography makes use of four-pole lenses which enable the deflection of the beam to be magnified in only one desired direction. By magnifying the deflection by a factor k in both directions as in the conventional oscilloscopes, one loses in intensity by a factor $k^{8/3}$. If, however, a magnification in one direction is used, the loss is only $k^{4/3}$.

8352 THE FINITE BEAM SPACE-CHARGE LIMITED DIODE AS A NOISE TRANSDUCER. R.A.McFarlane.
Canad. J. Phys., Vol. 39, No. 4, 568-78 (April, 1961).

A method is presented for calculating the noise properties of a cylindrical electron beam from a space-charge limited diode electron gun. The multivelocity character of the beam is considered and correction is made for finite beam diameter. The ratio of anode noise current to full shot noise is found to depend on $\omega^{1/2}/V_{0a}$ where ω is the frequency and V_{0a} the anode voltage.

8353 MICROWAVE NOISE IN ACCELERATED ELECTRON STREAMS. R.A.McFarlane.
Canad. J. Phys., Vol. 39, No. 4, 579-87 (April, 1961).

Measurements were made of the noise current fluctuations on the electron beam from a space-charge limited diode electron gun, at 1400 Mc/s, 4250 Mc/s, and 9520 Mc/s. Theories which do not consider the finite beam diameter and the multivelocity nature of the stream in the region of the potential minimum are in poor agreement with experiment. The measurements here reported and those of other workers are compared with the results of theoretical calculations in which these two effects are considered. Significant improvement in agreement with experiment is realized.

8354 ENERGY SPECTRUM OF A BEAM EMITTED BY A HIGH-FREQUENCY SOURCE OPERATING AS AN ELECTRON SOURCE. F.Pradal and N.Colombie.
C.R. Acad. Sci. (France), Vol. 251, No. 8, 995-7 (Aug. 22, 1960).
In French.

The electron beam produced by a high-frequency source operating as an electron emitter was analysed using a magnetic spectrograph. The spectrum was found to be most intense at energies corresponding to the potential of the extracting electrode. When the oscillator power is reduced and for a given pressure, the energy spectrum narrows and becomes Maxwellian in form. R.C.Glass

8355 ELECTRON BEAM ANALYZER USING A PIEZOELECTRIC SCANNER. T.Fujii.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 434-44 (April, 1961).

The analyser is intended to investigate the current density distribution of a high current-density electron beam for use with a klystron or a travelling-wave tube. A pair of piezoelectric elements of barium titanate ceramic is used to drive a vibrating, pinholed target for the purpose of sampling the beam to be investigated. This enables direct observation of the current density distribution on a cathode-ray oscilloscope screen at any part of the electron beam under investigation, including the part very close to the anode aperture of the electron gun. Both PPI and A presentations are possible; only qualitative measurements can be made by the former type of presentation which, however, is indispensable for the purpose of observing the entire picture of the distribution at a glance. The latter is suitable for quantitative measurements of the distribution along a straight line on a cross-section of the beam. Either of these two types of presentation can be selected simply by turning a switch. The pressure in the useful part of the vacuum chamber can be made to as low as $10^{-6} \sim 10^{-7}$ mm Hg under typical operating conditions. The merits and demerits of the new analyser are fully discussed with particular reference to the resolving power of the observed pattern. Possible causes of error in the results are considered.

8356 CONSTRUCTION AND APPLICATION OF AN ELECTROLYTIC WEDGE-TANK. K.H.Schmidt.
Jenaer Jahrbuch (Germany), 1960 I, 216-27. In German.

A wedge-tank is described which is adjustable between a wedge angle of 0^0 and 10^0. A frequency of 435 c/s is used. There is a short discussion on errors and corrections with illustrated examples. K.C.Garner

SYSTEMATIC INVESTIGATIONS OF AN ELECTRO-
8357 STATIC IMMERSION OBJECTIVE. E.A.Soa.
Jenaer Jahrbuch (Germany), 1959 I, 115-53. In German.

The imaging properties have been investigated of an immersion objective consisting of a heated cathode and three electrodes. A flat demountable oxide cathode of small power input was specially developed, but some other cathode shapes were also used. Measurements were made of the dependence of the focal length on the voltage of the Wehnelt electrode, and the influence of the thickness, bore and separation of the electrodes was studied. Emission micrographs are shown, at about 2000 ×, of the oxide cathode and of a tantalum surface. The immersion lens was operated at maximum strength in order to minimize aberrations; a resolving power of 0.15 - 0.2 μ is claimed. V.E.Cosslett

ION EMISSION . ION BEAMS

AN ARC TYPE WATER-COOLED ION SOURCE FOR
8358 POSITIVE IONS. S.Z.R.Hashmi.
Indian J. Phys., Vol. 34, No. 3, 118-22 (March, 1960).

A source of simple construction and reliable operation is described in which the anode-filament assembly can be readily changed. The characteristic curves of the source are given. Operating at an arc current of 0.4 A a total beam current of 500 μA is produced with a probe potential of about 3000 V.

CALCULATION OF THE TRAJECTORIES OF IONS IN
8359 AN ION SOURCE OF THE NIER TYPE, IN THE PRESENCE OF AN AUXILIARY MAGNETIC FIELD. J.Chantreau.
C.R.Acad. Sci. (France), Vol. 252, No. 5, 695-7 (Jan. 30, 1961). In French.

Compares the ion trajectories in a Nier-type ion source in the presence of a magnetic field (50-500 gauss) by direct calculation and by a modified method of Gans. It is concluded that the latter method can be used satisfactorily and with saving of time provided the magnetic field strength is not too high.

A.E.I. Research Laboratory

MOLECULAR BEAM ELECTRON BOMBARDMENT DETECTOR.
See Abstr. 7508

MAGNETIC QUADRUPOLE LENSES WITHOUT IRON.
8360 PRODUCING A CONSTANT GRADIENT INDUCTION DISTRIBUTION. A.Septier.
J. Phys. Radium (France), Vol. 21, Suppl. No. 3, 1A-15A (March, 1960). In French.

Recalls the general properties of the fields in a system with quadrupolar symmetry, and gives expressions for the magnetic field and its radial gradient, in a system consisting of four current sheets, or four thick coils without iron. By properly choosing the transversal dimensions of the coils, it is possible to obtain for the gradient, in the whole space around the axis, a flatness which is better than 10^{-2}. From this point of view, strong focusing lenses without iron are better than quadrupole lenses of classical design.

INVESTIGATION OF THE SPUTTERING OF SILICON.
8361 S.P.Wolsky and E.J.Zdanuk.
J. appl. Phys. (USA), Vol. 32, No. 5, 782-6 (May, 1961).

A sensitive vacuum microbalance was used to determine the sputtering yields for the argon—silicon system over an energy range of 34-800 eV. Preliminary data for the ion bombardment of silicon with CO_2 was also obtained. Variation of the discharge voltage provided information on the relative sputtering effectiveness of Ar^+ and Ar^{2+} ions. Extrapolation of the low-energy data indicates a probable threshold energy of 15-20 eV. The sputtering data indicate that the target surfaces were clean and reproducible. The experimental method is shown to be well suited to sputtering studies.

SPUTTERING THRESHOLDS.
8362 D.E.Harrison, Jr and G.D.Magnuson.
Phys. Rev. (USA), Vol. 122, No. 5, 1421-30 (June 1, 1961).

An attempt is made to give a logically coherent definition of the term "sputtering threshold", and establish criteria which may determine an experimental threshold. The Silsbee chain mechanism (Abstr. 8450 of 1958) and the experimentally observed preferred direction of emission from single crystals are used to establish a threshold theory. Two models are required, one generally applicable when the mass ratio is less than one, and another when it is greater than one. Single-crystal threshold laws are obtained, and polycrystalline laws follow for face-centred cubic crystals by averaging the single-crystal forms. An approximate technique for the evaluation of surface atomic binding energies is presented so that the thresholds can be compared with experimental results. In all cases the theoretical thresholds are less than or comparable to experimental "thresholds".

SPUTTERING OF COPPER BY BOMBARDMENT
8363 WITH IONS OF 5—25 keV.
P.K.Rol, J.M.Fluit and J.Kistemaker.
Physica (Netherlands), Vol. 26, No. 11, 1000-8 (Nov., 1960).

The results for the sputtering of polycrystalline copper by bombardment with positive ions of He, Li, C, N, O, Ne, Na, Mg, Al, Si, P, S, Cl, A, K, Ca, Cu, Zn, Sr, Zr, Cd, I, Hg and Tl are given. In general the sputtering ratio increases with increasing energy and increasing ion mass. For the heavier elements the increase of the sputtering ratios with increasing energy is much faster than for the lighter elements. For N^+- and Ne^+- ions impinging on copper a relative maximum in the sputtering ratio was found near 15 keV. The angular distribution of the sputtered material has been found have a Gaussian- rather than a cosine-distribution. This angular distribution is independent of the angle of incidence always symmetrical with respect to the normal on the target surface. The dependence of the sputtering ratio of the angle of incidence was studied. The increase is sharp for very oblique incidence. The sputtering action of N_2^+- and KI^+ -molecule ions was investigated.

PARTICLE ACCELERATORS

COHERENT ELECTROMAGNETIC EFFECTS IN HIGH-
8364 CURRENT PARTICLE ACCELERATORS. I. INTERACTION OF A PARTICLE BEAM WITH AN EXTERNALLY DRIVEN RADIO-FREQUENCY CAVITY. V.K.Neil and A.M.Sessler.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 256-66 (March, 1961).

A calculation is made of the interaction of a beam of particles in an accelerator with the radio-frequency cavity that provides the accelerating mechanism of the machine. A Hamiltonian for synchrotron motion is employed that makes the simultaneous solution of Maxwell's equations and the Vlasov equation, so that a self-consistent distribution of particles in synchrotron phase space is determined. The effective voltage on the cavity due to the beam charged particles is of the order of magnitude of the product of the total circulating current in the accelerator and the shunt impedance of the r.f. cavity. It has the net effect of producing a total voltage the cavity which is both less than the applied voltage, and shifted in phase with respect to it. The increase in the stable phase angle required so the particles will remain in phase with the accelerating radio frequency is calculated. The decrease in total voltage and increase in stable phase angle result in a decrease in stable phase space available for acceleration, and convenient expressions are given for these quantities in terms of parameters of the accelerator. It is shown that the consequences of the induced voltage may be alleviated by increasing the voltage applied to the cavity. Non-resonant interaction between the beam and cavity is not considered.

COHERENT ELECTROMAGNETIC EFFECTS IN HIGH-
8365 CURRENT PARTICLE ACCELERATORS. II. ELECTROMAGNETIC FIELDS AND RESISTIVE LOSSES.
V.K.Neil, D.L.Judd and L.J.Laslett.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 267-76 (March, 1961).

Coherent electromagnetic fields arising from an azimuthally modulated beam are considered. The beam is completely enclosed in a toroidal vacuum tank of rectangular cross-section and highly conducting walls. Expressions are given for the image currents arising from low harmonics of the beam circulation frequency. These expressions are then used to evaluate resistive losses in the walls of the chamber. Expressions are given for fields arising from harmonics of the revolution frequency high enough that the beam may be in resonance with a characteristic mode of the vacuum chamber. The results are generalized to provide a description of the electric field in the neighbourhood of a resonance. Numerical examples of resistive losses are given, indicating that these effects will not be serious for circulating currents of the order of 1 A. Some properties of high-order Bessel functions, required for a description of the resonant chamber modes and the energy lost in their excitation, are developed in an appendix.

8366 COHERENT ELECTROMAGNETIC EFFECTS IN HIGH CURRENT PARTICLE ACCELERATORS. III. ELECTROMAGNETIC COUPLING INSTABILITIES IN A COASTING BEAM. L.J.Laslett, V.K.Neil and A.M.Sessler.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 276-9 (March, 1961).

The electromagnetic interaction of an intense relativistic coasting beam with itself, including the effect of a nonperfectly conducting vacuum tank, or a quiescent r.f. cavity, is investigated theoretically. It is shown that the resonances that may occur between harmonics of the particle circulation frequencies and the electromagnetic modes of the cavities can lead to longitudinal instability of the beam. A criterion for stability of the beam against such longitudinal bunching is obtained as a restriction on the shunt impedance of the r.f. cavity, or the Q of the vacuum tank. This criterion contains the energy spread and intensity of the coasting beam, as well as the parameters of the accelerator. Numerical examples are given which indicate that, in general, the resonances with the vacuum tank will not cause instabilities, while those with an r.f. cavity can be prevented from causing instabilities by choosing the shunt impedance at a sufficiently low but still convenient value.

8367 A METHOD FOR EXPANDING THE PHASE-STABLE REGIME IN SYNCHRONOUS ACCELERATORS. L.L.Foldy.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1116-20 (March 16, 1961).

Possible advantages resulting from the use of non-sinusoidal radiofrequency accelerating potentials in synchronous accelerators in extending the regime of phase stability and in overcoming space charge effects are pointed out and discussed.

DESIGN OF CYCLOTRON POLE PIECES. See Abstr. 8368

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

DESIGN OF A SECOND HARMONIC FLUX GATE MAGNETIC FIELD GRADIOMETER. See Abstr. 7948

8368 THE DESIGN OF POLE-PIECES IN RELATIVISTIC ISOCHRON-CYCLOTRON. W.Wolff and V.Zehler.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 241-6. In German.

A theoretical and experimental investigation of the influence of the pole-face contour on the field in the air gap of a Thomas-type cyclotron. Lines of equal magnetic potential within the magnet and in the air gap are calculated by a process of approximation.

D.S.Parasnis

HIGH CURRENT SUPPLY FOR LARGE ELECTROMAGNETS. See Abstr. 8289

8369 ELECTRICAL CURRENT SHIMS FOR CORRECTING MAGNETIC FIELDS. W.A.Anderson.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 241-50 (March, 1961).

The design criteria of electrical current shims for high resolution nuclear magnetic resonance magnets are discussed. Specific current configurations are given for various corrections to magnetic field gradients of the first, second, third, and fourth orders.

MAGNETIC QUADRUPOLE LENSES WITHOUT IRON. PRODUCING A CONSTANT GRADIENT INDUCTION DISTRIBUTION. See Abstr. 8360

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

8370 AVERAGE FORCES IN ELECTROMAGNETIC SYSTEMS. W.E.Smith.
Austral. J. Phys., Vol. 14, No. 1, 152-9 (March, 1961).

The mechanical forces are usually evaluated from surface integrals of the Maxwell stresses. For a large class of systems it is shown that the time average force can be expressed in terms of directly measurable circuit-theory parameters. The system must be linear and loss free, but there is no restriction on the frequency of excitation.

8371 PERIODIC ELECTROMAGNETIC AND QUANTUM SYSTEMS. R.M.Bevensee.
Ann. Phys. (USA), Vol. 12, No. 2, 222-63 (Feb., 1961).

An analysis of periodic electromagnetic structures which is based on their resonant properties rather than their travelling-wave properties is developed. By expanding the fields of Maxwell's equations in a set of short-circuit modes, defined as the resonant modes within a unit cell of the structure bounded by electric shorting planes on the coupling surfaces and excited by tangential electric field on those surfaces, a determinantal equation is obtained for $k^2 = \omega^2 \mu_0 \epsilon_0$ for a given periodic phase shift ϕ. Alternately the fields in a set of open-circuit modes are expanded, defined as the resonant modes within a unit cell with magnetic shorting planes on the coupling surfaces and excited by tangential magnetic field on those surfaces. The same determinantal equation for $k^2(\phi)$ is obtained. The following theorems are proved for a general symmetric structure: (1) the irrotational modes with zero curl are not necessary for determining the passband curves, (2) the shape of a narrow passband is a simple $(1 \pm \cos\phi)$ curve between the cutoff frequencies, independent of the coupling between cavities, and (3) the sum of all the $k^2(\phi)$ associated with the passbands is the sum of all the k^2 lying on the $(1 \pm \cos\phi)$-curves between the actual cutoff frequencies, independent of the nature of the coupling. The determinantal equation for $k^2(\phi)$ can be obtained from variational expressions for k^2, and by analogy these lead to a variational expression for the energy of a periodic quantum system. The Schrödinger equation for the first energy band of an infinite line of positive ions is solved in terms of the first "short-circuit" and "open-circuit" eigenfunctions to illustrate the analysis. Then a cellular procedure is outlined for solving Schrödinger's equation variationally within a unit cell of a more complicated crystal. The procedure provides for continuity of both Ψ and $\nabla\Psi$ over the whole surface of a unit cell and should prove useful for many crystals with unit cells of arbitrary shapes, described by very general Hamiltonians.

8372 QUANTUM STATISTICAL DERIVATION OF THE MACROSCOPIC MAXWELL EQUATIONS. K.Schram.
Physica (Netherlands), Vol. 26, No. 12, 1080-90 (Dec., 1960).

Equations in matter are derived from equations for the field operators. Both the density operator formalism and the Wigner distribution function method are discussed. By both methods it can be proved that the quantum statistical ensemble averages of the microscopic electric and magnetic fields fulfil the usual macroscopic Maxwell equations.

8373 THE QUANTUM MECHANICAL EFFECTS OF MAGNETIC FIELDS CONFINED TO INACCESSIBLE REGIONS. M.Peshkin, I.Talmi and L.J.Tassie.
Ann. Phys. (USA), Vol. 12, No. 3, 426-35 (March, 1961).

When an electron is confined to a multiply connected region, fixed external magnetic fields in the excluded spaces can have observable effects on the scattering of the electron, as was pointed out by Aharanov and Bohm (see Abstr. 12997 of 1959). These effects occur also in bound state problems. Quantization of a simple mechanical model of the source of the field shows that it is indeed correct to treat the field as external. The observable effects are necessary for consistency with the uncertainty principle and with the classical limit. They arise not from forces exerted by the magnetic fields or by their vector potentials, but from modification of the quantum conditions.

8374 ON THE UNIQUENESS THEOREM FOR ELECTROMAGNETIC FIELDS. H.Unz.
Proc. Inst. Radio Engrs (USA), Vol. 48, No. 9, 1663-4 (Sept., 1960).

A proof is given of a theorem which states that a harmonic time-varying electromagnetic field is uniquely determined in a lossy, bounded region by prescribing the values of any one of three parameters over the surrounding surface. The field is not uniquely defined in a lossless region because of the possibility of resonant modes.

V.G.Welsby

8375 AXIALLY SYMMETRIC STAGNATION POINT FLOW WITH HEAT TRANSFER IN MAGNETOHYDRODYNAMICS. G.Poots and L.Sowerby.
Quart. J. Mech. appl. Math. (GB), Vol. 13, 385-407 (1960).

The authors consider the steady axially symmetric stagnation point flow. The fluid is assumed to be incompressible, viscous and electrically and thermally conducting. The magnetic field is taken to be normal to the wall which is thermally insulated. The analysis reveals the existence of three regions of flow. In the first place there is the magneto-viscous layer of the same order of thickness as the boundary layer of non-conducting fluids. Lorentz force influences the behaviour of the motion in this region. Moreover the pressure distribution throughout this layer and the velocity distribution near the edge of the layer are greatly affected by the adjacent layer; the magneto-inviscid layer. The magneto-inviscid layer is the region of the flow in which the Lorentz force is comparable in magnitude with the inertia terms, but the viscosity is unimportant. This layer plays the role of a buffer layer between the magneto-viscous layer and the region of the potential flow in the free stream. Continuing their analysis, the authors discuss the magnetohydrodynamic effects on heat transfer. They find that, in the vicinity of the stagnation point, the presence of the magnetic field produces a considerable reduction in the local shear stress and the eigentemperature at the wall. The paper ends with an elegant discussion of the main results. This section contains many figures and tables. Mathematical Reviews (R.P.Kanwal

8376 AXIALLY SYMMETRIC STAGNATION-POINT FLOW OF AN ELECTRICALLY CONDUCTING FLUID UNDER TRANSVERSE MAGNETIC FIELD. T.Kakutani.
J. Phys. Soc. Japan, Vol. 15, No. 4, 688-95 (April, 1960).

Deals with an incompressible, viscous conducting fluid in the presence of a field with small magnetic Reynolds numbers. The velocity distribution modified by the magnetic field is calculated for several values of N (= SR_m, S: the pressure number, R_m: the magnetic Reynolds number). The shear stress on the wall is expressed in terms of b and $\phi''(0)$, where b is a characteristic parameter of the asymptotic inviscid flow and $\phi''(0)$ is the non-dimensional velocity gradient on the wall. The flow of this type may be considered as a simple model in the neighbourhood of the nose of a body of revolution moving through an ionized atmosphere at hypersonic speed. In this context, it may be convenient to use Bush's results for estimating b [Journal of the Aeronautical Sciences (USA), Vol. 25, 685 (1958)]. The ratio of the shear stresses with and without the magnetic field thus calculated is shown graphically as a function of N. It is found that the shear stress at the wall is considerably reduced by the hydromagnetic interactions.

8377 STOKES FLOW OF AN ELECTRICALLY CONDUCTING FLUID IN A UNIFORM MAGNETIC FIELD. K.Gotoh.
J. Phys. Soc. Japan, Vol. 15, No. 4, 696-705 (April, 1960).

The flow of an incompressible, viscous fluid past an obstacle is investigated using Stokes approximation. No particular configuration of the flow and the magnetic field is assumed, so that the result applies to the general three-dimensional problems. Sections 2 and 3 deal with the general theory. It is found that the neutrality of the electric charge density does not hold exactly, when the undisturbed magnetic field is not perpendicular to the vorticity vector. It is also found that the vorticity and the electric current density are confined in a paraboloidal region, thus making a "wake" which extends in the direction of the undisturbed magnetic field. Distribution of the electric charge density also shows the same structure. In Section 4, the flow past a sphere is investigated as an example. The drag is obtained in a power series of the Hartmann number M. The component of the drag perpendicular to the undisturbed magnetic line of force is found to be larger than its parallel component. It is pointed out as an interesting feature of the three-dimensional case that the velocity field includes components which express the two-dimensional irrotational flow.

8378 A SOLUTION OF THE EULER–MINKOWSKI EQUATIONS AND ITS PHYSICAL INTERPRETATION. G.Crupi.
Atti Semin. Mat. Fis. Univ. Modena (Italy), Vol. 9, 1-12 (1959-60). In Italian.

A solution is obtained of the Euler–Minkowski equations for wave motion in an incompressible, inviscid, electrically conducting fluid acted on by a constant external magnetic field. This solution is interpreted as a plane wave propagated in an arbitrary prescribed direction (not perpendicular to the field direction). It is found that under certain conditions the waves may be attenuated, stationary or amplified, and their group velocities are correspondingly greater than, equal to, or less than the phase velocity. F.A.E.Pirani

8379 FLOW OF A VISCOUS, ELECTRICALLY CONDUCTIN FLUID ALONG A CIRCULAR CYLINDER OR A FLAT PLATE WITH UNIFORM SUCTION. M.Yasuhara.
J. Phys. Soc. Japan, Vol. 15, No. 2, 321-5 (Feb., 1960).

An exact solution of the flow of a viscous, electrically conducting fluid with an externally imposed magnetic field normal to the wall is obtained for the incompressible flow along a circular cylin or a flat plate with uniform suction. Analytical results show that i the Alfvén wave velocity is smaller than the suction velocity, a physically possible solution is obtained under a given boundary con dition, and that the applied magnetic field acts on the flow as a decelerating action as expected from the general property of magnetic force, and as a result of this, the coefficient of skin-friction is reduced and that of Maxwell's stress is increased while the total drag is kept unchanged. Further, the solution reduces to that of the asymptotic suction flow of a non-conducting fluid when the magnetic field tends to zero.

8380 STATIONARY MOTION OF A CONDUCTING FLUID THROUGH A TUBE IN PRESENCE OF A TRANSVERS MAGNETIC FIELD. G.A.Grinberg.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 1, 18-22 (Jan., 1961).

Taking account of viscosity and neglecting inertia, solutions of the magnetohydrodynamic equations are obtained. Appropriate solutions are found by the way of an auxiliary fourth-order equation. [English translation in: Soviet Physics–Technical Physics (USA)]. R.Eisensch

8381 EXPERIMENTS IN MAGNETO-FLUID DYNAMICS. R.A.Alpher.
Phys. Today (USA), Vol. 13, No. 12, 26-31 (Dec., 1960).

Review article.

8382 STUDIES ON MAGNETO-HYDRODYNAMIC WAVES A OTHER ANISOTROPIC WAVE MOTIONS. M.J.Lightn
Phil. Trans A (GB), Vol. 252, 397-430 (March 31, 1960).

Begins with a method of evaluating Fourier integrals asympto ically in many dimensions, for large values of their arguments. This is used to investigate partial differential equations in four va ables, x, y, z and t, which are linear with constant coefficients, but which may be of any order and represent wave motions that a anisotropic or dispersive or both. It gives the asymptotic behavio (at large distances) of solutions of these equations, representing waves generated by a source of finite or infinitesimal spatial exte It concentrates particularly on sources of fixed frequency, and so tions satisfying the radiation condition; but an Appendix is devote waves generated by a source of finite duration in an initially quie cent medium, and to unstable systems. The mathematical result are given in a partial physical interpretation by arguments deter mining the velocity of energy propagation in a plane wave travers an anisotropic medium. These show, among other facts not gener ally realized, that even for non-dispersive (e.g. elastic) waves, th energy propagation velocity is not in general normal to the wave fronts, although its component normal to them is the phase veloci The second section starts from the important and striking proper of magnetohydrodynamic waves in an incompressible, inviscid an perfectly conducting medium, of propagation in one direction only a given disturbance propagates only along the magnetic lines of fo which pass through it, and therefore suffers no attenuation with d tance. There are cases of astrophysical importance where densit are so low that attenuation due to collisional effects — for examp electrical resistivity — should be negligible over relevant length scales. It can be therefore asked how far the effects of a non-collisional nature which are neglected in the simple theory, partic larly compressibility and Hall current, would alter the unidirecti attenuation-less propagation of the waves. These effects have bee included previously in magnetohydrodynamic wave theory, but the directional distribution of waves from a local source was not obtained. This problem explains the need for the mathematical theo just described, and gives a comprehensive illustration of its appli cation.

8383 RADIAL PULSATION OF A CYLINDER IN A MAGNE FIELD. P.K.Raju and H.S.Talwar.
Z. Astrophys. (Germany), Vol. 52, No. 1, 31-6 (1961).

The radial pulsation of a self gravitating, infinitely conductin cylinder in the presence of a magnetic field having toroidal and poloidal components is studied. It is found that the magnetic field increases the frequency of pulsation.

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

8384 ADDENDUM TO OUR PAPER "ON THE CONSERVATION LAWS OF THE ELECTROMAGNETIC FIELD IN MOVING DIELECTRICS". J.I.Horváth and J.Gyulai.
Acta phys. chem. Szeged.(Hungary), Vol. 3, No. 1-4, 33-4 (1957). In German.

The equivalence of the radiation tensors of Beck and Marx, physically evident, but not proved in the original paper [Horvath, and Gyulai, ibid, Vol. 2, 39 (1956)] is now proved tensor-analytically. F.A.E.Pirani

REVERBERATION ROOM FOR ELECTROMAGNETIC WAVES. See Abstr. 8191

8385 A NOVEL TYPE OF HIGH POWER PULSE TRANSMITTER. K.Landecker and K.S.Imrie.
Austral. J. Phys., Vol. 13, No. 4, 638-54 (Dec., 1960).

A system of generation of radio waves is described which makes use of a symmetrical circular array of condensers charged through resistors and discharged through spark gaps in the manner of the Marx impulse generator. It is shown that exponential wavetrains of very high peak powers, of the order of 10 000 MW, may be radiated. The radiation resistance and radiation field of the structure are given and modification of the field pattern by parasitic elements is considered. Formulae and graphical aids are given which facilitate the design of such transmitters and experiments with various model transmitters are described. Consideration is given to circuit losses, particularly spark losses, and means are described to minimize these losses.

8386 RESONATORS FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS. W.Culshaw.
IRE Trans Microwave Theory and Tech. (USA), Vol. MTT-9, No. 2, 135-44 (March, 1961).

Further considerations on the mm-wave Fabry-Perot interferometer are presented. Computed Q values for parallel metal plate resonators indicate that at spacings around 2.5 cm, values 6×10^4 at 3mm, to 3×10^5 at 0.1 mm wavelengths are possible. The plates must, however, be quite flat. These results are important for many investigations, and in particular for mm and sub-mm wave maser research. For the aperture per wavelength ratios possible here, diffraction effects should be small. Consideration is given to using curved reflectors or focused radiation in applications where the fields must be concentrated. For this purpose, re-entrant conical spherical resonators are treated in detail, as regards operation in the TEM mode at high orders of interference. Expressions for the Q and shunt impedance are given, and high values are possible at mm and sub-mm wavelengths. Quasi-optical methods of coupling into and out of such a resonator are proposed, and the higher modes possible in such a resonator are considered. Results indicate that it could have application to the mm-wave generation problem, and that it represents a good resonant cavity for solid-state research at mm and sub-mm wavelengths, and for maser applications in particular.

8387 BACKWARD-WAVE MICROWAVE OSCILLATIONS IN A SYSTEM COMPOSED OF AN ELECTRON BEAM AND A HYDROGEN GAS PLASMA. R.Targ and L.P.Levine.
J. appl. Phys. (USA), Vol. 32, No. 4, 731-7 (April, 1961).

A travelling-wave interaction structure is used to investigate the properties of a low-density plasma formed by the interaction of an electron beam with hydrogen gas. In this experiment, microwave oscillations near the electron cyclotron frequency are observed as the result of growing waves in a beam plasma interaction. Electron densities are determined by observing the correlation between the measured frequencies of oscillation and the theoretical predictions of Trivelpiece and Gould (Abstr. 1132 of 1960) relating to backward-wave propagation in a beam-plasma system in a magnetic field. This electron density was verified by observation of the shift in the resonant frequency of a microwave cavity containing the plasma. The shift in the resonant frequency of the cavity gives a direct measurement of the electron plasma frequency and, hence, the electron density.

ELECTROMAGNETIC RADIATION FROM LIGHTNING STROKES. See Abstr. 7931

8388 GENERAL ANALYSIS OF OPTICAL, INFRARED AND MICROWAVE MASER OSCILLATOR EMISSION. J.R.Singer and S.Wang.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 351-4 (April 1, 1961).

General equations for coherent emission from microwave infrared and optical masers are derived. Except for very low power outputs an amplitude modulation is to be expected. This modulation, controlled by the pump energy, could be used in a communication system. D.Walsh

8389 PROPOSAL FOR AN INFRARED MASER DEPENDENT ON VIBRATIONAL EXCITATION. J.C.Polanyi.
J. chem. Phys. (USA), Vol. 34, No. 1, 347-8 (Jan., 1961).

Infrared maser action is proposed through population inversions of vibrational states of molecules achievable when energy of chemical reaction is converted into vibrational energy. The much lower transition probabilities for induced emission by vibrational transition as compared with electronic transition are expected to be balanced by the much larger mean radiational lifetimes of vibrationally excited states. Two types of vibrational population inversion are distinguished; complete inversion with respect to an entire vibration—rotation band, and partial inversion with respect to only certain vibration—rotation transitions within a band. It is shown that both types of inversion can occur in chemical reaction products. Experimental conditions necessary for maser action will include low temperature and pressure, to minimize collisional deactivation, and fast flow beyond the reaction-zone; pulsed operation will be desirable. Other factors contributing to population inversion by selective depopulation of certain levels and selective rotational cooling of heated gas are discussed. Effects of the types discussed may occur in the upper atmosphere. J.Sheridan

VOLTAGE-TUNED SWEPT-FREQUENCY RECEIVER. See Abstr. 8021

8390 EXCITATION AND AMPLIFICATION OF CYCLOTRON WAVES AND THERMAL ORBITS IN THE PRESENCE OF SPACE CHARGE. R.Adler, A.Ashkin and E.I.Gordon.
J. appl. Phys. (USA), Vol. 32, No. 4, 672-5 (April, 1961).

The effect of space charge on the motion of the entire beam and the internal orbits of individual electrons in the transverse fields of cyclotron-wave amplifiers is considered. It is shown that the cyclotron-wave couplers excite the motion of the entire beam and have no influence on the internal motion. With sufficiently high space charge, the amplification of the cyclotron wave in quadrupolar fields is not accompanied by internal-orbit amplification. Experiments illustrating the difference between orbit pumping and wave pumping are described. It is concluded that space charge plays a vital role in allowing high gain without beam expansion and interception.

OBSERVED DIELECTRIC WAVEGUIDE MODES IN THE VISIBLE SPECTRUM. See Abstr. 8225

CYLINDRICAL DIELECTRIC WAVEGUIDE MODES. See Abstr. 8224

MULTIPLE SCATTERING OF WAVES BY WEAK RANDOM IRREGULARITIES IN THE MEDIUM. See Abstr. 8242

SCATTERING OF ELECTROMAGNETIC WAVES FROM CONCENTRIC INFINITE CYLINDERS. See Abstr. 8241

DIFFRACTION OF PLANE ELECTROMAGNETIC WAVES BY A CYLINDRICAL PLASMA: DETERMINATION OF ELECTRON DENSITY DISTRIBUTION. See Abstr. 8320

SONAR ANALOGUES OF RADAR. See Abstr. 8190

8391 PROPAGATION IN A PLASMA. P.A.Clavier.
J. appl. Phys. (USA), Vol. 32, No. 4, 578-82 (April, 1961).

The boundary conditions for a radio signal incident normally on a layer of plasma are discussed. It is shown that 10 different modes must in general propagate in the layer, instead of the usually assumed six. The 10 modes are obtained when the Langevin form of the force is used in Boltzmann's equation.

8392 FOCUSING OF RADIO WAVES REFLECTED FROM A ROUGH CURVED IONOSPHERE. J.D.Whitehead.
Austral. J. Phys., Vol. 13, No. 4, 621-4 (Dec., 1960).

The reflection of radio waves from a partially rough, curved ionosphere is considered. The relationship between the amplitude of the echo, A, and phase path P when the ionosphere moves overhead with a horizontal velocity V at a height h is the same as that for a smooth curved ionosphere, i.e.

$$A^2 \propto 1 - \frac{h}{2V^2}\frac{d^2P}{dt^2},$$

although because of the different physical conditions the large increases in echo amplitude observed when reflection takes place from a smooth ionosphere are not expected for reflection from a rough ionosphere. A method of testing the relationship experimentally is suggested.

8393 EFFECTS OF EQUATORIAL SPREAD-F IRREGULARITIES ON C.W. TRANSMISSIONS.
M.S.V.Gopal Rao and B.Ramachandra Rao.
Canad. J. Phys., Vol. 39, No. 4, 596-603 (April, 1961).

A study is made of the effects of spread-F conditions on c.w. transmissions between Colombo and Waltair over a distance of about 1300 km. It is shown that under suitable conditions increased fading rate of the received c.w. signals is a sufficient indication of spread F and gives a genuine index of its intensity. Pulse and c.w. methods are used simultaneously to study the time variations of spread-F intensity at separated points. The results indicate that the horizontal extent of spread-F occurrence in the N-S direction is greater than 650 km. The probability distributions of signal amplitudes in the c.w. fading records were closer to Rayleigh type under normal conditions than during spread-F conditions. It is suggested that the c.w. flutter fading is caused by the presence of spread-F irregularities in the appropriate zone of reflection in the F-region of the ionosphere.

8394 M.U.F. FACTOR AND SOLAR ACTIVITY.
C.S.R.Rao and J.C.Bhargava.
Indian J. Phys., Vol. 34, No. 2, 85-91 (Feb., 1960).

Deals with the variation of $M(3000)F_2$ factor with sunspot activity. The ionospheric data for Delhi and Ahmedabad for the period 1950 to 1958 have been considered. The analysis indicate that a fairly good linear relationship exists between $M(3000)F_2$ a sunspot number for both the places. A preliminary study of the variation of Y_m and h_o with sunspot activity (Ahmedabad) has als been made.

Radiofrequency Spectroscopy Techniques

8395 A RECORDING MICROWAVE SPECTROGRAPH.
D.Ilias and G.Boudouris.
IRE Trans Microwave Theory and Tech. (USA), Vol. MTT-9, No. 144-52 (March, 1961).

The principle of operation of a recording microwave spectrograph designed for use in the study of the absorption and the inde of refraction of gases under medium pressures (1 mm Hg to 1 atm are presented. The apparatus results from a similar spectrograp with synchroscope, in which the responses of the cavity resonator are interpreted by means of a pulse method. The high performan of the apparatus render its use advantageous, not only as a spectr graph, but also as an accurate recording refractometer, as well a a direct-reading Q meter.

8396 DAMPING BY COHERENT RADIATION IN NUCLEAR MAGNETIC RESONANCE. H.Benoit.
J. Phys. Radium (France), Vol. 21, No. 4, 212-16 (April, 1960). In French.

The shape of absorption or emission lines in nuclear magnet resonance is calculated when the damping by coherent radiation is considerable. Contrary to the usual condition, passages by resonance sweeping the magnetic director field or frequency are not equivalent and are studied separately. The second sweeping mode points out the band with the maser type amplification when the stimulated emission of radiation is observed. The theoretical predictions are compared with experimental results obtained in a magnetic director field of about one gauss. With the same equatio it is possible to calculate the circuit frequency range of oscillatio and pulling when the system works as an auto-oscillator of maser type.

NUCLEAR PHYSICS

8397 HIGH ENERGY PHYSICS.
M.J.Moravcsik.
Phys. Today (USA), Vol. 13, No. 12, 20-5 (Dec., 1960).

A report of the tenth annual "Rochester" conference held in Aug., 1960.

APPARATUS
PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

8398 DETECTOR DEVELOPMENTS IN ELEMENTARY PARTICLE PHYSICS. S.Devons.
Sci. Prog. (GB), Vol. 49, 273-81 (April, 1961).

A brief survey of the types of particle detector which have been developed in the past few years. J.L.Redding

8399 INSTRUMENTATION FOR MEASUREMENT OF β-AND γ-ACTIVITY USING AN IONIZATION CHAMBER.
J.J.Engelmann and H.Roquefort.
Medical Electronics Conference, Paris, 1959 (see Abstr. 14326 of 1960) p. 553-61. In French.

Discusses apparatus for β-and γ-activity measurements, especially adapted for medical purposes. Two ionization chambers are described: The "C$\beta\gamma$I" chamber is designed for measurements of specific activity of β-emitter solutions above 50 $\mu c/cm^3$ with a precision of ± 5%, and for surface dose measurements of β applicators, with a precision of ± 7%. The well type γ-chamber is designed for activity measurements of γ sources or solutions in th range 0.1 μc to 100 mc with a precision of ± 5%. The electrodes are so designed that the measurements are independent of the source dimensions. Several types of d.c. amplifiers suitable for ionization currents measurements are briefly described.

8400 GAS IONISATION DETECTORS.
W.R.Loosemore.
Nuclear Power (GB), Vol. 5, 84-9 (Aug., 1960).

The article supplements previous articles [Gray and Loosemore, Nuclear Power (GB), Vol. 4, 74 (Feb.); 97 (April); 103 (May 112 (June, 1959)] by tabulating the characteristics of GM counters proportional counters, mean current ionization chambers, and pulse ionization chambers, currently available from British manufacturers. J.L.Reddi

8401 SCINTILLATION COUNTERS.
R.B.Owen.
Nuclear Power (GB), Vol. 5, 82-6 (Oct., 1960).

Tables are given of the characteristics and suppliers of commercially available phosphors for scintillation counting, photo multipliers for scintillation counting and scintillation detector assemblies. J.L.Reddi

8402 PULSE SHAPE IN SCINTILLATION COUNTERS.
T.Tanasescu.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 39-44 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A mathematical analysis of the pulse shape in scintillation ounters in terms of the scintillation decay time τ, the photomulti- ier transit-time spread t_1 and the time constant τ_0 of the photo- ultiplier output circuit. The results are presented graphically for range of values of τ_0/t_1 and τ/t_1, and in terms of the time of the aximum voltage t_M. J.B.Birks

8403 INVESTIGATION OF THE LIGHT YIELD OF SOLID SCINTILLATORS EXCITED BY α-,β-AND γ-RAYS.
.Pabst.
naer Jahrbuch (Germany), 1960 I, 245-308. In German.

An extensive study of various scintillators is reported including pectral emission measurements and relative efficiencies. Response r organic scintillators is determined by using a monoenergetic nversion electron source (Cs^{137}). The efficiency of plastic scin- llators in relation to solute concentration is determined. Optimum lues are found for α and β irradiation. Applications of α and β adiations to thickness measurement with suitable scintillator etectors are described. G.F.J.Garlick

8404 FLUORESCENT RESPONSE OF SCINTILLATION CRYSTALS TO HEAVY IONS.
.Newman, A.M.Smith and F.E.Steigert.
hys. Rev. (USA), Vol. 122, No. 5, 1520-4 (June 1, 1960).

The light output of CsI(Tl) was measured as a function of energy r incident ions of B^{10}, B^{11}, C^{12}, N^{14}, O^{16}, and F^{19}. The response of E 102 plastic and anthracene scintillators was also measured for ns of N^{14} and O^{16}, respectively. The response of CsI was essentially near for energies above 6 MeV/A, where A is the mass number of e incident ion. The NE 102 was linear for energies above 4 MeV/A. he anthracene data showed slight curvature even at 9 MeV/A. It ould appear that the response of CsI differs somewhat among rystal samples.

SCINTILLATION RESPONSE OF ACTIVATED INORGANIC RYSTALS TO VARIOUS CHARGED PARTICLES.
ee Abstr. 7727

8405 EFFECTS OF VARIATIONS IN THE AMBIENT AIR ON THE CALIBRATION AND USE OF IONIZATION OSEMETERS. G.P.Barnard, G.H.Aston and A.R.S.Marsh.
ondon: Her Majesty's Stationery Office (1960) 31 pp. [National hysical Laboratory].

This is a critical survey of present knowledge and practice applying correction factors for air conditions during measure- ents with ionization dosimeters. Extensive tables are appended ving temperature and pressure corrections for all conditions kely to be encountered. The difference in response of free-air nd cavity chambers to changes in humidity is discussed and rrections tables for humidity are given. D.V.Mabbs

8406 A POLYACRYLAMIDE GAMMA DOSIMETER.
A.L.Boni.
adiation Research (USA), Vol. 14, No. 4, 374-80 (April, 1961).

A simple chemical dosimeter was developed which is based on ne degradation of polyacrylamide by X- and γ-radiation. It has a ensitivity range between 50 and 7500 r and is essentially unaffected y fast and thermal neutron fields. It is dose-rate- and energy- ndependent, it is stable over long periods of time before and after radiation, and it is simple to make and read. Additionally, it is uited for inclusion in a multipurpose foil dosimeter to be employed or personnel monitoring in criticality incidents.

Track Visualization

8407 THE RELATIVISTIC INCREASE OF THE SPECIFIC PRIMARY IONIZATION IN HELIUM.
.Ballario, A.De Marco, R.D.Fortune and C.Verkerk.
uovo Cimento (Italy), Vol. 19, No. 6, 1142-54 (March 16, 1961).

The relativistic increase of the specific primary ionization roduced by electrons in a helium—alcohol mixture, was determined om measurements of mean length made on photographs of post- xpansion tracks in a Wilson cloud chamber. The results show a garithmic increase of the relative ionization as a function of p/mc om p/mc ~ 5 up to p/mc ~ 300 and there is some evidence of ne density effect at p/mc ~ 678 where the primary ionization relative to minimum is 1.50 ± 0.03. The extent of the logarithmic increase and the ratio of the plateau to the minimum ionization are significantly greater than those calculated for pure helium from the theory of Budini and Taffara. Measurements of the specific primary ionization by the technique of gap counting are shown to be uncorrelated with variations in the relative condensation efficiency (θ) in the range $0.2 \leq \theta \leq 0.6$. This enables precise measurements of ionization to be made which do not necessitate critical adjustments of expansion conditions in the cloud chamber.

8408 KINEMATICAL ANALYSIS OF INTERACTION VERTICES FROM BUBBLE CHAMBER DATA.
J.P.Berge, F.T.Solmitz and H.D.Taft.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 638-48 (May, 1961).

A high speed computer programme for the kinematical analysis of bubble chamber events is described. The programme treats individual particle interaction or decay vertices, subjecting the measured variables to the equations of energy and momentum according to the least-squares criterion. This is done in four different cases in which the problem is overdetermined, and a fifth case is calculated in which the problem is just determined. The adjusted or computed variables corresponding to each particle are obtained in all cases as well as the first-order error matrices for each type of variable. A connected chain of vertices may be processed in sequence.

8409 PHOTOGRAPHIC STUDY OF FISSION TRACKS OF U^{235} IN NUCLEAR EMULSIONS. R.Pfohl and J.P.Lonchamp.
J. Phys. Radium (France), Vol. 21, No. 10, 717-27 (Oct., 1960). In French.

Evidence is given of the characteristic thinning down of the "light-ion" track in certain emulsions (G5; L4; C2). The explanation of this experimental fact is based on the action of rays of weak energy and is confirmed by comparison with A^{40} ion tracks and by use of low sensitivity emulsions (K0; K—1; K—2) or diluted emulsions.

NUCLEAR FIELD THEORY

8410 CONCERNING A "STRONG" COUPLING METHOD IN THE QUANTIZED FIELD THEORY. Yu.M.Lomsadze.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 143-50 (April, 1961).

A new approximate method especially intended for "strong" coupling variants is proposed for solving the equation of motion in quantized field theory. This method revives the idea of the old "strong" coupling method, with the essential difference that in the new method use is made of the exact reduction of the interaction Hamiltonian of quantized fields to diagonal form, without "fixing" the nucleon current.

8411 ON THE NATURE OF THE ELECTROMAGNETIC FIELD. T.Gotō.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 388-99 (May, 1961).

In an attempt to identify the electromagnetic field as an affine connection for spinors, the nature of the electromagnetic interaction and the electric charge is investigated. All spinors interact with the electromagnetic field. Possibility of charge independence is studied. It is suggested that the violation of the charge independence by the electromagnetic field is caused by the violation of the flatness of space-time.

8412 CLASSICAL GAUGE INVARIANCES OF QUANTUM ELECTRODYNAMICS. B.Jouvet.
Nuovo Cimento (Italy), Vol. 20, No. 1, 28-58 (April 1, 1961). In French.

The principles of gauge invariance are stated and their violations occuring in perturbation theory are studied: i.e., the well known photon self-energy; the commonly ignored photon—photon interaction term. A new equation for the photon field is then constructed, involving new renormalization constants, which is such that the S-matrix is gauge invariant, without using regularization. Gauge invariance of the field equations supplies relations for the new renormalization constants. Non-perturbative calculation proves the consistency of these relations and connects the new constants to the observable quantities. The values of these constants are then calculated to every order of perturbation theory.

8413 ELECTRODYNAMIC QUANTIZATION PROCESS. C.L.Hammer and R.H.Good, Jr.
Ann. Phys. (USA), Vol. 12, No. 3, 463-75 (March, 1961).

A quantum theory of the free Maxwell field has been given by Hammer and Good (Abstr. 5639 of 1958) that avoided discussion of nonphysical photons. The extension to include the interaction with electrons is given in this paper. This approach leads to a formulation equivalent to the gauge-independent theory of Belinfante and Lomont. A complete discussion of the integrals of motion is given, including their connections with displacement operators.

8414 EMISSION OF FAST PARTICLES IN A HETEROGENEOUS MEDIUM. M.L.Ter-Mikaelyan.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 43-61 (April, 1961).

This paper is concerned with the radiation arising in the passage of relativistic particles of constant velocity through an arbitrary periodical heterogeneous medium. The necessary condition of the origin of radiation, the condition of resonance, is derived on the basis of the laws of conservation of energy and momentum. The total radiation in a periodic medium is composed of radiations of different orders (harmonics). For each order of radiation there is a special frequency interval and its own energy threshold. The radiation of each order is concentrated around the lower boundary of the respective spectrum intervals. The intensity of resonance radiation and its spectrum are calculated (a) for a medium changing its properties by the cosine law, (b) for a medium of arbitrary periodicity with a weak change of density and (c) for a stratified medium, pro - ably the most suitable for experimental purposes. Different effects influencing the accuracy of the formulae derived are analysed in the last section. The properties of resonance radiation enumerated above can be applied in the physics of particles of ultra-high energy.

8415 TOWARDS A TWO-FIELD THEORY OF ELEMENTARY PARTICLES. R.E.Marshak and S.Okubo.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1226-48 (March 16, 1961).

It is shown why the symmetry principle between the baryon triplet (Λnp) and lepton triplet ($\mu e \nu$) suggests a two-field theory of elementary particles. One massless spinor field is used to describe the nucleons and light leptons and a second spinor field with finite bare mass the "strange" particles Λ and μ. The two-field model resembles the theories of Heisenberg and Nambu in several respects but there are also important differences which are pointed out.

8416 COVARIANT SPIN OPERATORS AND ASSOCIATED CONSERVATION LAWS FOR A SPINOR FIELD. F.Calogero.
Nuovo Cimento (Italy), Vol. 20, No. 2, 280-96 (April 16, 1961).

The covariant operators which may serve for the description of the spin of a Dirac field are considered, and their physical meaning discussed, with the aim of investigating the associated conservation laws in the case of an interacting spinor field. Particular attention is given to the case of a Dirac field interacting with an assigned electromagnetic field. Other operators, containing explicitly the coordinates, are then introduced, which also commute with the Dirac operator $D = \gamma_\mu \partial_\mu - m$ and lead therefore to conservation laws for a free spinor field. The validity of these conservation laws in the case of an interacting spinor field is again investigated, with a particular emphasis on the case when the source of interaction consists of an assigned electromagnetic field.

8417 NON-LOCAL TRANSFORMATIONS AND NON-LOCAL CONSERVATION LAWS FOR FREE FIELDS. F.Calogero.
Nuovo Cimento (Italy), Vol. 20, No. 2, 297-315 (April 16, 1961).

Non-local transformations are introduced, which, when applied to fields obeying homogeneous non-zero mass equations, define new fields obeying massless equations. These transformations are used to extend to the case of massive fields the conservation laws connected with the invariance properties of massless equations.

8418 ISOSPIN AND PARITY IN NONLINEAR SPINOR THEORY. H.P.Dürr.
Z. Naturforsch. (Germany), Vol. 16a No. 4, 327-45 (April, 1961). In German.

The isospin transformation properties and the space reflection symmetry in a nonlinear field theory of elementary particles, as proposed by Heisenberg and co-workers, are studied. It is shown that the nonlinear equation

$$\gamma_\nu \frac{\partial}{\partial x_\nu} \psi \pm l^2 \gamma_5 \gamma_\mu \psi (\bar{\psi} \gamma_5 \gamma_\mu \psi) = 0$$

for a 4 component spinor operator ψ is equivalent to the equation

$$-i\sigma_\nu \frac{\partial}{\partial x_\nu} \chi \pm l^2 \sigma_\mu \chi (\chi^* \sigma_\mu \chi) = 0$$

for a 4 component Weyl-isospinor operator χ. In this Weyl representation of the theory the Pauli–Gürsey transformations and the Touschek transformation can be replaced by the conventional forms of the isospin rotations and the gauge transformation of the first kind, respectively. An attempt is made to introduce parity in a rigorous manner using the invariance of the equation under l-inversion $l \to -l$. Some important aspects of symmetry operations which involve transformations of parameters, are discussed. By virtue of the parity symmetry a Dirac notation may be introduced, and the nonlinear equation then corresponds to a Touschek invariant equation of the Dirac type with nonlinear vector- and axial-vector terms of equal strength. The existence of particles with finite mass suggests a degeneracy of the ground state "world" with respect to parity. Finally, the Tamm–Dancoff method is applied to estimate of the masses of nucleons and bosons with spin and isospin zero or one, using the simpler Weyl representation with and without consideration of the parity symmetry, respectively.

8419 A REMARK ON THE ISOBARIC SPIN SPACE. T.A.J.Maris.
Nuclear Phys. (Internat.), Vol. 24, No. 2, 346-52 (April, 1961).

Usually a physical meaning is given only to half of the solutions of the Klein–Gordon equation for a 4-component spinor. It is shown that the isobaric spin degrees of freedom of a free fermion–isofermion field can be simply interpreted by considering all the solutions of the Klein–Gordon equation to be meaningful. Explicit expressions for the isobaric spin operators in spinor and configuration space quantities are given. The conserved current of one of the isobaric spin components is the axial vector current.

8420 SYMMETRY PROPERTIES OF STRONG AND WEAK INTERACTIONS. G.Lüders.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 9-39.

Defines and discusses the operators T, C and P in quantum field theory. Shows the physical consequences of the TCP theorem, and of invariance under each operator separately. R.J.N.Phillips

8421 ON SOME QUESTIONS OF THE V–A THEORY. R.Gatto.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 336-64.

The possible non-locality of weak interactions, the conserved vector current hypothesis, and the use of dispersion relations are described and discussed. R.J.N.Phillips

8422 ON THE OBSERVABILITY OF THE SIGNS OF THE STRONG INTERACTION COUPLING CONSTANTS. D.B.Lichtenberg.
Nuovo Cimento (Italy), Vol. 20, No. 2, 324-33 (April 16, 1961).

Criteria are given for the observability of the signs of coupling constants appearing in elementary particle interactions. The results are applied to particular strong interaction Lagrangians. For a commonly considered meson–baryon interaction with eight coupling constants, it is shown that only four (independent) relative signs are observable. The signs of the coupling constants in certain meson–meson interactions are discussed briefly. Some difficulties in measuring the observable signs are mentioned.

8423 ELECTROPRODUCTION OF SCHIZONS. P.Budini and G.Furlan.
Nuovo Cimento (Italy), Vol. 18, No. 5, 1280-2 (Dec. 16, 1960).

The electroproduction of schizons is studied as a means of investigating the existence of an intermediate boson field as a transmitter of weak interactions. E.A.Sanderson

8424 RESONANCE POLES AND THE REACTION MATRIX. R.Oehme.
Nuovo Cimento (Italy), Vol. 20, No. 2, 334-43 (April 16, 1961).

Within the framework of relativistic dispersion theory the reaction matrix (K-matrix) is considered as an analytic matrix-

function. For the case of two coupled two-particle channels, it is shown that the elements of this matrix are regular functions except for cuts due to dynamical branch lines of the amplitudes and possible isolated poles. Expressing the reaction amplitudes in terms of the elements of the reaction matrix makes it possible to exhibit the Riemann surface of these amplitudes. The connection between resonances and poles of the amplitudes in secondary Riemann sheets is discussed with the help of the reaction-matrix formalism. The possible connection between a resonance and a bound state is considered.

8425 APPLICATIONS OF THE SAKATA MODEL FOR ELEMENTARY PARTICLES. E.Hormann.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 514-18 (May, 1961).

Simple sub-symmetries of the three-dimensional unitary group are used to described and classify all interactions, including in particular electromagnetic interactions. It is seen that all known types of interaction, and only these, appear. Application to the leptons succeeds in forbidding the direct electromagnetic μ–e decay. A suggestion is made for the removal of the μ–e mass degeneracy, and the range of applicability of the approach is discussed.

8426 CUSP PHENOMENA IN THE REGION OF TWO NEIGHBORING THRESHOLDS.
J.Sucher, G.A.Snow and T.B.Day.
Phys. Rev. (USA), Vol. 122, No. 5, 1645-8 (June 1, 1961).

Previous discussions of the cusp phenomena at the threshold for a new reaction (Abstr. 4746 of 1958; 11839 of 1959) are extended to the case of two neighbouring thresholds. The S-matrix is constructed from an $n \times n$ κ matrix in such a way as to ensure that the physical S-matrix is unitary when only r of the n channels are open. As a special application, the amplitude for the reaction $\pi^- + p \rightarrow \Lambda^0 + K^0$ is studied in the region of the Σ^- and Σ^0 thresholds.

8427 ON THE RUIJGROK–VAN HOVE MODEL.
D.B.Fairlie.
Physica (Netherlands), Vol. 27, No. 1, 95-8 (Jan., 1961).

The model is studied for a particular choice of coupling constants. The resulting theory (Abstr. 8377 of 1957) gives an exact criterion for the existence of ghost states. In the limit, as the number of intermediate states increases to simulate a realistic field theory, the ghost behaviour disappears.

8428 MATRIX REPRESENTATION OF POLARIZATION.
W.H.McMaster.
Rev. mod. Phys. (USA), Vol. 33, No. 1, 8-28 (Jan., 1961).

Describes the use of the density matrix and the Stokes parameters (expectation values of the Pauli matrices) for expressing the cross-sections of numerous polarization-sensitive interactions in matrix form. The advantage of this method is that it shows the analogy of the polarization of particles and photons to the familiar polarization of light. W.A.Hepner

8429 INTRODUCTORY CONSIDERATIONS ON ELEMENTARY CONSTITUENTS AND THEIR INTERACTIONS.
L.Rosenfeld.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 1-8.

Remarks on general properties of elementary particle fields, transformation groups and conservation laws. R.J.N.Phillips

8430 FOURTH ORDER MESON EQUATION AND NEUTRON–PROTON SCATTERING. S.P.Misra.
Indian J. Phys., Vol. 34, No. 2, 92-7 (Feb., 1960).

The neutron–proton differential scattering cross-section is obtained with a fourth order meson equation proposed by Bhabha (Abstr. 4708 of 1950) and Thirring (Abstr. 851 of 1951) which explains the anomalous magnetic moments of nucleons. It is noted that for moderate energies the results disagree as violently with experiment as conventional meson theory satisfying the Klein–Gordon equation does.

8431 ANALYTIC PROPERTIES OF PRODUCTION AMPLITUDES. P.V.Landshoff and S.B.Treiman.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1249-56 (March 16, 1961).

It is shown that a production amplitude, considered as a function of a single scalar invariant, inevitably has complex singularities when four other scalar invariants are fixed at physical values. For the process $N + \pi \rightarrow N + \pi + \pi$, with the nucleon–nucleon momentum transfer as the variable, the singularities can appear close to the pole to which extrapolations have been made when the other scalar invariants are fixed at typical experimental values.

8432 S-MATRIX, LEFT-HAND CUT DISCONTINUITY AND POTENTIAL. A.Martin.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1257-65 (March 16, 1961).

Assuming a two-body potential which is a continuous superposition of exponential potentials it is first shown in a straightforward way how to get, from the left-hand cut discontinuity of the S-wave scattering amplitude, the scattering amplitude itself, without any ambiguity. On the other hand, a one to one correspondence is established between the unphysical cut discontinuity and the inverse Laplace transform of the potential. When the discontinuity is known in a certain range of values the inverse Laplace transform of the potential is exactly known in a corresponding range of values. An extension of the treatment when a repulsive hard core is present at short distance is given. The usefulness of the inverse Laplace transform of the potential as an intermediate tool in the calculation of the scattering amplitude is discussed.

8433 LOW ENERGY LIMIT OF COMPTON SCATTERING WITHOUT T, C, P INVARIANCE. E.Kazes.
Nuovo Cimento (Italy), Vol. 20, No. 1, 20-7 (April 1, 1961).

When TCP invariance only is valid, Compton scattering from a spin $-\frac{1}{2}$ particle is shown to be entirely determined by its mass, charge, magnetic and electric dipole moment in the two lowest orders of the frequency.

8434 SCATTERING BY A GIVEN CLASS OF NON-CENTRAL FORCES. R.Vinh Mau and A.Martin.
Nuovo Cimento (Italy), Vol. 20, No. 2, 390-402 (April 16, 1961).

Previous work (Abstr. 2499, 12859 of 1960) has shown the remarkably simple properties of the partial wave scattering amplitude and corresponding radial functions derived from a potential which is a continuous superposition of exponential or Yukawa potentials. Here these results are extended to the case where non-central forces are present in the scattering of two spin one-half particles. A method of calculation of the S-matrix elements is given in terms of the inverse Laplace transforms of the various radial potentials; the analytic properties of these matrix elements are established and integral representations of the wave-functions are obtained.

8435 RELATIVISTIC ONE-PION EXCHANGE NUCLEAR POTENTIAL. S.N.Gupta.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 160-2 (April, 1961).

The exact relativistic one-pion exchange nuclear potential is derived in the centre-of-mass system, and the relationship between the relativistic potential and the Schrödinger equation is discussed.

8436 ON POTENTIAL SCATTERING OF RELATIVISTIC PARTICLES. F.Prats.
Proc. Roy. Soc. A (GB), Vol. 259, 403-8 (Dec. 29, 1960).

The S-matrix for the problem of potential scattering of relativistic particles can be expressed in terms of resonance states under restrictions on the potential which are similar to those of the non-relativistic case. The S-matrix is a double-valued function of momentum or energy with branch points as given by the relativistic energy-momentum relationship.

8437 THE ELECTRIC POLARIZABILITY OF THE NEUTRON IN THE STATIC MESON THEORY. A.Kanazawa.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 524-6 (May, 1961).

The electric polarizability of the neutron is recalculated in the framework of the static meson theory. The recalculated values of the electric polarizability are $\alpha = 1.1 \times 10^{-42}$ cm^3 for a Gaussian cut-off with cut-off momentum $k_C = 5.6$ meson mass, and $\alpha = 1.0 \times 10^{-42}$ cm^3 for an inverse square cut-off with the same cut-off momentum. These values are almost half of those which were obtained by Barashenkov and Barbashov.

8438 DISPERSION RELATIONS AND THE CAUSALITY CONCEPT. J.M.Lozano and M.Moshinsky.
Nuovo Cimento (Italy), Vol. 20, No. 1, 59-75 (April 1, 1961).

It is well known that the scattering function $S(\kappa)$ associated with a cut potential has certain analytic properties that make it satisfy dispersion relations. It is of interest to see how these

analytic properties are modified when the potentials are not cut-off at a certain point, but continue to infinity, going asymptotically to zero there. The discussion is first carried using a causality condition enunciated as follows: The wave-function associated with any initial wave packet remains bounded for all time. As a consequence of the causality condition, it was found that it is no longer the $S(\kappa)$, but a new function, which the authors call the dispersion function, that satisfies the analytic properties that imply dispersion relations. These analytic properties are also checked directly from the Schrodinger equation. Finally, to discuss the significance of the poles of the dispersion and scattering functions, the scattering by the Eckart potential is analysed in detail, obtaining the time dependent Green function in terms of basic interaction Green (BIG) functions associated with poles of the dispersion function. From the behaviour of the BIG functions, as functions of time, one can also obtain restrictions on the analytic behaviour of the dispersion function.

8439 ON FERMION LOOPS OF TWO VERTICES. B.Deo.
Indian J. Phys. Vol. 34, No. 4, 159-68 (April, 1960).

The imaginary part of the retarded matrix element for a closed loop of two vertices is deduced by perturbation theory. It is used to evaluate the photon and meson vacuum polarization effects by assuming dispersion relations. Some difficulties regarding the mesic vacuum polarisation are shown to be removed by considering the vertex correction. The formulae are applied to deduce the decay rates of some fundamental particles and the results obtained are in good agreement with experiments.

ELEMENTARY PARTICLES

8440 ELECTRODYNAMIC PROPERTIES OF BARYONS IN THE UNITARY SYMMETRY SCHEME.
S.Coleman and S.L.Glashow.
Phys. Rev. Letters (USA), Vol. 6, No. 8, 423-5 (April 15, 1961).

Some relations among baryon magnetic moments and mass differences are deduced. D.W.L.Sprung

8441 ON A POSSIBLE ENHANCEMENT OF RELATIVISTIC INCREASE IN IONIZATION.
P.Budini, L.Taffara and C.Viola.
Nuovo Cimento (Italy), Vol. 20, No. 2, 265-73 (April 16, 1961).

A new method is described by which the relativistic increase of primary specific ionization in mixtures of elements could be augmented due to the reabsorption of Cherenkov radiation. The theory is given and applied to two examples.

Photons

COHERENT SCATTERING OF 1.17 MeV AND 1.33 MeV GAMMA RAYS THROUGH SMALL ANGLES. See Abstr. 8694

8442 RESOLUTION OF BREMSSTRAHLUNG EXPERIMENTS. H.H.Thies.
Austral. J. Phys., Vol. 14, No. 1, 174-87 (March, 1961).

Investigates how mathematical approximations and statistical errors are transmitted into computed cross-sections in the analysis of experimental bremsstrahlung yield data. The resolution of bremsstrahlung experiments is defined in analogy with optical resolution and an expression for the practical evaluation of resolution is derived. Methods of cross-section computation, and smoothing and curve-fitting are discussed.

8443 RADIATION FROM FAST PARTICLES MOVING THROUGH MAGNETIC MATERIALS. T.B.Day.
Phys. Rev. (USA), Vol. 122, No. 4, 1028-36 (May 15, 1961).

The problem of the generation of a changing magnetic field due to the interaction of a fast particle with a magnetic medium is studied. This combined Cherenkov–spin wave effect is shown to give rise to a "ringing" of the spin system under certain conditions of frequency and angle of observation, at least within an approximate evaluation of the general Green's function for the problem. Some striking differences from the usual Cherenkov effect are discussed and possibilities of using this effect as a neutral magnetic moment detector or as a probe of magnetic materials are mentioned briefly.

Neutrinos

8444 THE THEORY OF THE NEUTRINO. B.Touschek.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 40-66. .

Develops the theory of fermions, and in particular neutrinos, from fundamentals. Leads up to two-component theories, and the relation of γ_5-invariance to vanishing mass. R.J.N.Phillips

NEUTRINOS, GRAVITATION AND GEOMETRY. See Abstr. 8050

8445 EMISSION OF PHOTONEUTRINOS AND PAIR ANNIHILATION NEUTRINOS FROM STARS.
Hong-Yee Chiu and R.C.Stabler.
Phys. Rev. (USA), Vol. 122, No. 4, 1317-22 (May 15, 1961).

Field-theoretic calculations of the cross-sections for the photoneutrino process, $\gamma + e^- \rightarrow e^- + \nu + \bar{\nu}$, and the pair annihilation process, $e^+ + e^- \rightarrow \nu + \bar{\nu}$, are performed in order to obtain the neutrino luminosity of very hot stars ($T_c \gtrsim 5 \times 10^8$ °K). The energy loss rate which is obtained for the latter process is sufficient to determine the rate of evolution of the stellar core when $T_c \gtrsim 2 \times 10^{9}$°K.

Electrons

8446 ELECTROMAGNETIC PROPERTIES OF ELECTRONS AND MUONS. L.M.Lederman.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 392-402.

Measurements of the electric and magnetic dipole moments are reviewed and discussed. R.J.N.Phillips

8447 ELECTRON AND PHOTON POLARIZATION. H.Frauenfelder.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 280-98.

Describes the chief methods of measuring electron and photon polarization, mentioning their advantages and disadvantages. R.J.N.Phillips

ANNIHILATION OF POSITRONS IN LiH. See Abstr. 7569

8448 POSITRONIUM FORMATION IN HELIUM. H.S.W.Massey and A.H.Moussa.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 811-16 (March, 1961).

The cross-section for formation of positronium on impact of a positron with a normal helium atom is calculated by Born's approximation for positron energies up to 125 eV. As judged by the size of the maximum cross-sections obtained at positron energy of 27 eV, the coupling between elastic scattering and positronium formation is far from weak. This suggests that virtual formation of positronium may play an important part in the elastic scattering of slow positrons by helium atoms. The coupled equations for dealing with this effect are derived.

Nucleons

8449 PHYSICAL ONE-NUCLEON AND TWO-NUCLEON WAVE FUNCTIONS IN FIXED SOURCE THEORY.
J.Mandelbrojt.
Nuovo Cimento (Italy), Vol. 20, No. 2, 366-74 (April 16, 1961).

A non-perturbative approximation of the physical one-nucleon and two-nucleon wave-function in fixed source theory is given. The states are given in an analytic form, from which expectation values of operators can be calculated in an explicit closed form.

8450 ELECTROMAGNETIC FORM FACTORS OF THE NUCLEON AND PION–PION INTERACTION.
S.Bergia, A.Stanghellini, S.Fubini and C.Villi.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 367-71 (April 1, 1961).

The isoscalar and isovector nucleon form factors are each approximated by a constant plus a single resonance term. The

latter, for the isovector case, presumbly arises from a T = 1, J = 1 two-pion resonance, which has to have an energy of about 4.7 m_π in order to fit the form factors for small momentum transfer, in agreement with other considerations. In the isoscalar case the required T = 0, J = 1 three-pion resonance has to have an energy about 2-3 pion masses. Some consequences of this are discussed.
E.J.Squires

8451 POSSIBLE EFFECT OF COLLECTIVE CORRELATION BETWEEN VACUUM NUCLEONS IN PION PHYSICS.
O.Hara.
Phys. Rev. Letters (USA), Vol. 6, No. 8, 425-7 (April 15, 1961).
It is argued that if the bare nucleon mass were as small as the pion mass, the nucleon vacuum state would be a collective state of BCS type. Pion–nucleon interactions would be reduced, assuming g^2 to be fixed. This effect would help to explain the T = $\frac{3}{2}$ s-wave amplitude.
D.W.L.Sprung

8452 PROPOSAL FOR THE DETERMINATION OF THE MESONIC MEAN SQUARE RADIUS OF NUCLEONS FROM "KNOCK-ON" PION PRODUCTION. G.Domokos.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1221-5 (March 16, 1961).
A method is proposed for determining the mesonic m.s. radius of nucleons from the differential cross-section of "knock-on" pion production. The essence of the method consists in extrapolating the differential cross-section as a function in the nucleon recoil momentum to unphysical values. The size of the unphysical region decreases with increasing primary energy. Possible limitations of the method are discussed briefly.

8453 ON ISOBARIC EXCITATION OF NUCLEONS IN COLLISIONS WITH FAST PARTICLES.
V.V.Glagolev, V.Petržílka and K.D.Tolstov.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 126-31 (April, 1961).
An analysis is made of the possible contribution of isobaric states to collisions of nucleons with nucleons of momentum 10 GeV/c and π^--mesons of momentum 7 GeV/c. In both cases the excitation energy in the centre-of-mass system is identical. The contribution of the isobaric states produced in the isotropic decay of an isobar with 1.24 GeV mass is shown to be small.

8454 THE $^1S_0$ NUCLEON INTERACTION IN THE BOUNDARY CONDITION MODEL. E.L.Lomon and M.Nauenberg.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 474-9 (May, 1961).
The nucleon–nucleon interaction model consisting of an energy independent boundary condition with an exponential potential tail is solved analytically for S states. The range of the potential is chosen to be approximately half of a meson Compton wavelength. The three remaining model parameters are fitted to the $^1S_0$ scattering length, effective range, and 210 MeV phase shift. The strength of potential required is in agreement with the expectations of a meson theory. The phase shifts predicted at other energies between 0 and 310 MeV are satisfactory.

8455 DISPERSION THEORETIC APPROACH IN NUCLEON–NUCLEON SCATTERING. S.Furuichi and S.Machida.
Nuovo Cimento (Italy), Vol. 19, No. 2, 396-9 (Jan. 16, 1961).
Assuming the Mandelstom representation for the nucleon–nucleon scattering, partial wave dispersion relations have been derived. This letter reports on singlet even parity states in particular. Impact parameter arguments are used to simplify the dispersion relations and explicit solutions obtained. For the D wave, the phase shift can be made to agree with previous, potential model, calculations by introducing the scattering length as a parameter.
D.W.L.Sprung

NUCLEON–NUCLEON CROSS-SECTIONS AT > 0.8 BeV. See Abstr. 8492

Protons

PHOTOPROTONS PRODUCED BY 245 ± 15 MeV GAMMA RAYS ON CARBON. See Abstr. 8700

8456 TRANSVERSE MOMENTUM OF PARTICLES EMITTED IN 4.2 GeV PROTON–PROTON COLLISIONS.
M.H.Blue, J.J.Lord, J.G.Parks and C.H.Tsao.
Nuovo Cimento (Italy), Vol. 20, No. 2, 274-9 (April 16, 1961).
The transverse momentum spectra of pions and protons produced in inelastic 4.2 GeV proton–proton collisions are presented. Shapes of the observed momentum spectra seem to be independent of the number of particles produced in an interaction; however, the observed proton momenta tend toward higher values (by about a factor of 2) than the observed pion momenta. A transverse momentum spectrum for elastically scattered protons is compared to the proton spectrum from inelastic events. Godd agreement is obtained for momenta above 300 MeV/c. Values of the proton transverse momentum less than about 100 MeV/c are much more probable for elastically scattered protons, while values around 150 MeV/c appear more probable for inelastically scattered protons.

8457 MEASUREMENTS OF THE POLARIZATION IN PROTON–HELIUM ELASTIC SCATTERING.
J.Sanada, K.Nisimura, S.Suwa, I.Hayashi, K.Fukunaga, N.Ryu and M.Seki.
J. Phys. Soc. Japan, Vol. 15, No. 5, 754-9 (May, 1960).
The scattering method was used. Incident proton or alpha-particle beam was obtained from the INSJ 160 cm variable energy cyclotron. Three interdependent measurements, in which the polarization produce was equal to P_1P_2, P_2P_3 or P_3P_1, were made. The following results were obtained:

$$P_1(6.2\ \text{MeV}, 130.0^\circ) = 0.92 \pm 0.11$$
$$P_2(11.5\ \text{MeV}, 61.1^\circ) = -0.45 \pm 0.06$$
$$P_3(9.1\ \text{MeV}, 61.1^\circ) = -0.45 \pm 0.06,$$

where angles and energies are those in the centre-of-mass system. Experimental values of the polarization agreed well to the values calculated by using phase shifts, which were obtained from the analysis of the angular distribution of the scattering cross-sections.

8458 A CONVERGENT SET OF INTEGRAL EQUATIONS FOR SINGLET PROTON-PROTON SCATTERING.
S.Ciulli and J.Fischer.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 465-73 (May, 1961).
Elastic nucleon–nucleon scattering is studied by using the two-dimensional spectral representation of Mandelstam. In this first paper, the convergence problem arising from the combination of the forward dispersion relation with the unitarity condition on the physical cut is solved via a conformal transformation.

VELOCITY-DEPENDENT SINGLET POTENTIALS FOR p–p SCATTERING PHASE-SHIFTS. See Abstr. 8539

8459 PHOTO-PROTON SPECTROMETER.
K.Murray.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 347-50 (March, 1961).
A detector system is described which can be used to observe protons in the energy range 2-10 MeV, with a discrimination factor against γ-ray background greater than 100 to 1 for γ-ray intensities less than 10^3/sec entering the scintillator. The instrumental line-width of the detector is about 7% for 5 MeV protons.

Neutrons

8460 MEASUREMENT OF THE COLLISION MEAN FREE PATH OF PENETRATING SHOWER PRODUCING COSMIC RAY NEUTRONS IN LEAD.
G.Bozóki, E.Fenyves and L.Jánossy.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 412-21 (May, 1961).
The collision mean free path of penetrating shower producing cosmic-ray neutrons was measured with an anticoincidence counter arrangement in lead. The detector selected neutrons having a mean energy of about GeV. The collision mean free path and the corresponding collision cross section were found to be $\lambda_c^{Pb} = (208 \pm 12)\text{g/cm}^2$ and $\sigma_i^{Pb} = (1652 \pm 95)\text{mb}$, respectively, From this the inelastic nucleon–nucleon cross-section was estimated to be $\bar{\sigma}_1 = (24 \pm 5)\text{mb}$. Comparison of these results with those obtained at accelerator energies shows, that the inelastic or collision cross-section of neutrons as well as the inelastic nucleon–nucleon cross-section in lead very probably remain constant from 1 GeV to about 30 GeV.

8461 PHASE-PARAMETER REPRESENTATION OF NEUTRON–PROTON SCATTERING FROM 13.7 TO 350 MeV.
M.H.Huli, Jr, K.E.Lassila, H.M.Ruppel, F.A.McDonald and G.Breit.
Phys. Rev. (USA), Vol. 122, No. 5, 1606-19 (June 1, 1961).
Results of gradient searches, by means of an IBM 704 machine, for phase parameters representing neutron–proton scattering are reported. The analysis made use of most available measurements. The number of "measurements" used in the final searches was

293 with 35 additional ones which were used to obtain composite values. Most of the fits join reasonably smoothly to the $^3S_1$ phase shift curve at low energies. The validity of charge independence was assumed and the more probable among the T = 1 phase-parameter sets obtained in a previously described series of searches for phase-parameter fits to p–p data (Abstr. 499 of 1961) were therefore employed for this T. The one-pion exchange values were used for the larger L and J. Independent sets of searches started with phase parameters corresponding to the Gammer–Christian–Thaler potential, and the Gammel–Thaler potential respectively. The procedure was varied by employing a weighted mean of fits obtained from the two different starting points as a new starting set and other devices described in the text. The final fits are appreciably better than the starts, the mean square deviation being reduced by a factor ~20 in some cases. A rough division of the final fits into related families according to the behaviour of the parameters K_3 and ρ_3 can be made. The value of additional measurements and especially those of the triple-scattering parameters and polarisation correlation is pointed out. Tests on reasonableness of one of the better fits from the point of view of representation by a static potential were made, with satisfactory results.

8462 THE QUASI-CLASSICAL APPROXIMATION FOR NEUTRON SCATTERING. R.E.Turner.
Physica (Netherlands), Vol. 27, No. 2, 260-4 (Feb., 1961).

The evaluation of Van Hove's space–time correlation function in the quasi-classical approximation (Abstr. 8679 of 1954) is discussed. It is shown that Schofield's imaginary time shift (Abstr. 9366 of 1960) is correct to order $\hbar$ and furthermore that this approximation should be a very good one for most scattering substances, at moderately high temperatures.

8463 GROUP-THEORETICAL TREATMENT OF TIME- AND ENERGY-DEPENDENT MULTIPLE SCATTERING WITH APPLICATION TO THE SLOWING-DOWN OF NEUTRONS.
E.Guth and E.Inönü.
J. math. Phys. (USA), Vol. 2, No. 3, 451-8 (May-June, 1961).

Wigner developed a group-theoretical method for those problems of multiple scattering in which the elementary scattering law is invariant under a group of transformations. The integral transforms, used in more standard treatments for the reduction of convolutions, come in here more naturally through the representations of the groups of transformations. Wigner's work is extended here to include the time-dependent slowing-down of neutrons. In this case a group of linear transformations comes in, which does not yield orthogonality. Nevertheless, it is possible to determine all positive time moments of the distribution function and from them the distribution function itself. The conditions for the existence of the group are that the total scattering cross-section is proportional to v^γ (γ is any real number) and that either the ratio of absorption to scattering cross-section is constant (including zero) or that the absorption cross-section varies as 1/v. Moreover, it is assumed that the angular dependence can be anisotropic, but does not depend on energy in the centre-of-mass system. For the special case of no absorption and spherically symmetric elastic scattering in centre-of-mass system, this solution reduces to Waller's recent exact expression. As a further generalization, the authors discuss the group which, with the same assumptions about the cross-sections, exists for the case of time–energy–space–direction dependence. Here also, the group-theoretical method yields naturally all positive moments of the distribution functions.

8464 MEASUREMENT OF THE ENERGY OF THE GAMMA RADIATION FROM NEUTRON CAPTURE BY HYDROGEN. J.E.Monahan, S.Raboy and C.C.Trail.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 400-11 (May, 1961).

A scintillation spectrometer with an anticoincidence annulus of NaI is used to measure the energy of the gamma ray that follows the capture of a neutron by hydrogen. The measurement is made simultaneously with the calibration of the spectrometer system in terms of six reference gamma rays. The results indicate a value of 2219 ± 2 keV for the binding energy of the deuteron. A discussion of this result relative to other measurements of this and related quantities is presented.

8465 GERMANIUM CRYSTAL AS A NEUTRON MONOCHROMETER AND THE DETERMINATION OF ITS HIGHER ORDER CONTAMINATIONS.
J.T.Wajima, B.M.Rustad and E.Melkonian.
J. Phys. Soc. Japan, Vol. 15, No. 4, 630-41 (April, 1960).

In order to cover the wavelength range 1 ~ 4 A with neutron crystal spectrometers, an attempt was made of using a germanium crystal as a neutron monochrometer. Germanium has a diamond cubic structure and the second order (222) reflection is theoretically forbidden. The intensity ratio of third to first order neutrons, I_3/I_1, at thermal energy with a 1/v, BF_3 counter was determined experimentally by a double crystal method using a second silicon crystal analyser, to be 0.023 ± 0.002 in agreement with the theoretically predicted values, $I_3/I_1 = 0.0245$ and $I_4/I_1 = 0.0055$. A maximum value of 0.2% was also measured for the second order contamination in the same way. The total higher order contamination determined from the transmission of pyrex glass plates was (4.7 ± 0.5)% at thermal energy, assuming only the third order contamination. The comparison of Ge, Si and NaCl crystals as monochrometers is discussed. The experiment indicates the successful use of a germanium crystal in the angstrom region as a neutron monochrometer and also confirms the ways of determining higher order contaminations.

Mesons

8466 ON ZERO MASS MESON–MESON SCATTERING.
B.Deo.
Indian J Phys., Vol. 34, No. 3, 131-40 (March, 1960).

The forward scattering matrix elements for the scattering of two mesons (zero mass) is calculated from pair reproduction cross section by the method of analytic continuation. This is compared with the Feynman matrix elements to the required order. By comparing the results of the two methods, the value of the counter $\lambda\phi^4$ term has been evaluated.

8467 LAW OF CONSERVATION OF MUONS.
G.Feinberg and S.Weinberg.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 381-3 (April 1, 1961).

The possibility of $\mu \to e$ decay being forbidden by an additive or multiplicative conservation law is considered. Some experimental tests for the two forms of conservation law are suggested.
E.J.Squires

8468 ASYMMETRY OF THE ANGULAR DISTRIBUTION OF ELECTRONS FROM $\mu \to e$ DECAY.
I.I.Gurevich, B.A.Nikolsky and S.A.Ali-Zade.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 480-7 (May, 1961).

The asymmetry of the angular distribution of electrons from $\mu \to e$ decay was studied in magnetic fields by detecting the $\pi \to \mu \to e$ decays in photoemulsion. As a result it is found that longitudinal magnetic fields from 20 000 to 30 000 G do not cancel totally the depolarizing effect of the medium (photoemulsion) on the μ-meson.

8469 ON THE MUON g-FACTOR.
A.Petermann.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 403-6.

Some remarks on the theoretical significance of this quantity, and on the current limits of experimental precision.
R.J.N.Phillips

ELECTROMAGNETIC PROPERTIES OF MUONS.
See Abstr. 8446

8470 PHOTODISSOCIATION OF THE μ MESON.
M.E.Ebel and W.D.Walker.
Phys. Rev. (USA), Vol. 122, No. 5, 1639-40 (June 1, 1961).

The cross-section for the production of a charged vector boson by the dissociation of a high-energy μ-meson beam undergoing Coulomb scattering is calculated. The cross-section for such a process is $(1-3) \times 10^{-34}$ cm^2 in Pb. Possible experiments for the detection of such decays are discussed.

8471 SINGLE SCATTERING OF 2 BeV/c MUONS IN NUCLEAR EMULSIONS.
C.Y.Kim, S.Kaneko, Y.B.Kim, G.E.Masek and R.W.Williams.
Phys. Rev. (USA), Vol. 122, No. 5, 1641-5 (June 1, 1961).

The single scattering of high-energy muons from emulsion nuclei was measured using a monoenergetic beam of muons produced at the Berkeley bevatron. The median momentum of muons was 2.00 ± 0.03 BeV/c with a spread of no more than ±3.5%. Nuclear emulsion stacks were exposed to this muon beam behind the targets used for a counter experiment. The results of the counter experiment were reported earlier (Abstr. 7257 of 1961). The muon tracks recorded in nuclear emulsions were followed by a special fast-scanning technique, and a total of 682 single-scattering events were

found from 743 m of track following. For the muon beam accepted in the emulsion scanning, the pion contamination was measured to be 1.3 ± 0.2%. These pions contribute to the integral muon scattering data by about 3% for scattering angles greater than 1°. The observed scattering distribution which extends up to 3° scattering angle, or momentum transfer of about 100 MeV/c, is in good agreement with the electromagnetic theory predictions and complements the counter experiment which covered momentum transfers of 70-400 MeV/c.

8472 A NOTE ON THE FERMI–TELLER "Z-LAW".
A.Astbury, P.M.Hattersley, M.Hussain, M A.R.Kemp and H.Muirhead.
Nuovo Cimento (Italy), Vol. 18, No. 5, 1267-8 (Dec. 16, 1960).

An experiment is reported on the capture of negative μ-mesons in PbF_2. The number of decay electrons produced as a function of time was obtained, and agreed well with the prediction of the "Z-law". J.E.Paton

8473 μ-MESON CAPTURE AND DECAY.
J.Steinberger.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 375-91.

Experimental results for these processes are reviewed and compared with the γ–A theory. An experiment on the internal conversion of γ-rays from stopped pions in H is also described. R.J.N.Phillips

8474 SEARCH FOR ELECTRONS FROM MUON CAPTURE.
M.Conversi, L.di Lella, A.Egidi, C.Rubbia and M.Toller.
Nuovo Cimento (Italy), Vol. 18, No. 6, 1283-6 (Dec. 16, 1960).

A counter experiment to measure the branching ratio for the process $\mu^- + Cu \rightarrow e^- + Cu$. No clear example of the process was detected in conditions which allow an upper limit to be fixed for the branching ratio $R <\sim 5.9 \times 10^{-6}$ at a 90% confidence level. S.J.Goldsack

NUCLEAR CAPTURE OF MUONS WITH ELECTRON EMISSION.
See Abstr. 7395

8475 THE ELECTRON DECAY MODE OF THE PION.
G.Fidecaro.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 374.

A summary of work published elsewhere (Abstr. 367 of 1960) establishing that $\pi \rightarrow e + \nu$ exists and agrees with theory. R.J.N.Phillips

8476 PHOTONS FROM THE RADIATIVE PION DECAY.
D.M.Binnie, S.L.de S.Barros and B.D.Hyams.
Nuovo Cimento (Italy), Vol. 20, No. 1, 140-51 (April 1, 1961).

The detection of photons from the radiative pion decay mode $\pi \rightarrow \mu + \nu + \gamma$ is reported. While there are several uncertainties in the final figures, the results are consistent with the V-A theory of weak interactions and with nuclear emulsion investigations of anomalous π–μ decays.

8477 THE DECAY OF NEGATIVE π-MESONS STOPPED IN LIGHT ELEMENTS AND INSULATORS
G.Culligan, D.Harting, N.H.Lipman, L.Madansky and G.Tibell.
Nuovo Cimento (Italy), Vol. 20, No. 2, 351-8 (April 16, 1961).

Positive and negative beams of 170 MeV/c π-mesons, from which the π-mesons were selected by time-of-flight, were stopped in Be, B_4C, Teflon and Al targets. The ratio of the numbers of electrons produced in the negative and positive beams, by π–μ–e decay, was determined for each of these materials. Assuming that no decay of negative π-mesons occurs in the Al target, an upper limit of 1% is found for the decay probability of negative π-mesons stopped in either Be, B_4C or Teflon.

8478 HELICITY OF μ^- MESONS FROM π-MESON DECAY.
G.Backenstoss, B.D.Hyams, G.Knop, P.C.Marin and U.Stierlin.
Phys. Rev. Letters (USA), Vol. 6, No. 8, 415-16 (April 15, 1961).

The arrangement is described for obtaining the polarized muon beam from the CERN proton-synchrotron. It had a momentum of 8 GeV/c with about 15% spread, an intensity of 2×10^3 per pulse and a polarization of 0.85. The sign of the polarization was measured by Møller scattering in magnetized iron. Knock-on electrons were detected and their energy measured in a shower detector of 20 layers of alternate sheets of iron and plastic scintillator. The helicity was found to be +1.17 ± 0.32, in agreement with the theoretical prediction of +1. A.Ashmore

8479 PRELIMINARY RESULTS OF A MEASUREMENT OF THE DIFFERENTIAL CROSS-SECTION FOR SINGLE π^0 MESON PHOTOPRODUCTION IN HYDROGEN.
G.Cortellessa and A.Reale.
Nuovo Cimento (Italy), Vol. 18, No. 6, 1265-6 (Dec. 16, 1960).

A measurement with a resolution, both in γ-ray energy and π^0-meson c.m.s. angle, two or three times better than previously was made. The second resonance peak of the process at 56° c.m.s. angle was found at a laboratory energy of about 700 MeV with a width of the order of 50 MeV. F.Herbut

8480 A MODEL FOR DOUBLE PHOTOPRODUCTION OF CHARGED PIONS. II.
D.Boccaletti, G.De Franceschi and C.Gualdi.
Nuovo Cimento (Italy), Vol. 20, No. 2, 375-89 (April 16, 1961).

Using the matrix element for double photoproduction of charged pions constructed in (Abstr. 5752 of 1961), the π^- energy spectrum at three fixed angles and the π^- angular distribution at three fixed energies are calculated. Also the $\frac{3}{2}\frac{3}{2}$ final state interaction between the π^+ and the proton is taken into account; the resulting correction changes very little the form of the π^- spectrum. The aim of the calculation is to see if it is possible to separate experimentally the predictions from those of Drell. As in the first part, the γ energy is taken as 900 MeV.

8481 ELASTIC PHOTOPRODUCTION OF NEUTRAL PIONS FROM DEUTERIUM.
A.Ramakrishnan, V.Devanathan and G.Ramachandran.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 163-8 (April, 1961).

The elastic photoproduction of neutral pions from deuterium was studied under the impulse approximation using the Chew–Low amplitude for the photoproduction of π^0 from nucleons. The differential cross-sections were obtained at various photon energies (1.5, 2.0 and 2.5 in units of pion mass) and they are in good agreement with the available experimental values. Studies of the final spin state of the deuteron were also made.

8482 PHOTOPRODUCTION OF PIONS IN CARBON.
T.R.Palfrey, B.M.K.Nefkens, L.Mortara and F.J.Loeffler.
Phys. Rev. (USA), Vol. 122, No. 4, 1323-30 (May 15, 1961).

Positive and negative pions were produced by photons on a carbon target and observed at laboratory angles of 35°, 73° and 121°. At each angle the yield of mesons of constant energy was observed by a magnetic spectrometer as a function of peak bremsstrahlung energy. Seven values of the latter ranging from 205 to 335 MeV were used. Yields and π^-/π^+ ratios corrected for various systematic experimental errors are presented. By using a photon difference method the bremsstrahlung spectra were unfolded from the yield curves to give meson cross-sections versus photon energy at fixed pion energies. These functions are compared with predicted yields which consider the internal momentum distribution of the target nucleons; the agreement is adequate.

8483 POLARIZATION OF THE RECOIL PROTON FROM π^0 PHOTOPRODUCTION IN HYDROGEN.
J.O.Maloy, G.A.Salandin, A.Manfredini, V.Z.Peterson, J.I.Friedman and H.Kendall.
Phys. Rev. (USA), Vol. 122, No. 4, 1338-40 (May 15, 1961).

The $D_{3/2}$ nature of the second resonance in neutral single pion photoproduction, $\gamma + p \rightarrow p + \pi^0$, suggested by Peierls (Abstr. 1676 of 1959; 9401 of 1960) is confirmed by additional experimental observation of the polarization of the recoil proton over a range of photon energies. The photon energy dependence of the polarization of the recoil proton over a range of photon energies. The photon energy dependence of the polarization at 90° c.m. is in substantial disagreement with alternative models suggested by Stoppini and Pellegrini (unpublished), and Landovitz and Marshall (Abstr. 1676 of 1959; 9401 of 1960) if the observed angular distributions are also considered. An experimental method using nuclear emulsion as scatterer-detector, in conjunction with a magnetic spectrometer, is shown to have both good energy resolution and reasonable counting rate.

8484 PHOTOPRODUCTION OF MESONS FROM HYDROGEN AND DEUTERIUM.
R.W.Kenney, E.A.Knapp, V.Perez-Mendez and W.A.Perkins.
Phys. Rev. (USA), Vol. 122, No. 5, 1631-3 (June 1, 1961).

The relative yields of positive pions produced from hydrogen and deuterium by the 340 MeV bremsstrahlung beam from a synchrotron were measured in the laboratory system at angles of 20°, 40°, and 60°, and at pion energies ranging from 45 to 145 MeV. The ratio of the relative yields of pions from deuterium and hydro-

gen was roughly constant as a function of angle, but decreased monotonically with pion energy from a value of 0.90 ± 0.05 at 45 MeV to a value of 0.55 ± 0.07 at 145 MeV. Comparison with the phenomenological theory of Chew and Lewis (Abstr. 2111 of 1952) indicates a gradual change from nucleon spin flip near threshold to no-spin-flip transitions above 140 MeV. Comparison with Uretsky's calculation involving final states shows fair agreement with plane-wave and shape-independent approximations. Poor agreement with the zero-range approximation shows that final-state interactions are important in the theory of photoproduction of pions from deuterium.

8485 PION–PION INTERACTION IN THE PHOTOPRODUCTION OF NEUTRAL PIONS WITH POLARIZED γ RAYS.
B.De Tollis and A.Verganelakis.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 371-4 (April 1, 1961).

Calculations are reported of the effect of a π–π, J = T = 1, resonance on the ratio of the reaction $\gamma + p \rightarrow \pi^0 + p$, for γ-rays polarized parallel and perpendicular to the production plane. The effect of a resonance at around $4m_\pi$ shows up strongly, and is not masked by uncertainties in the π–nucleon phase shifts.
E.J.Squires

8486 PION PRODUCTION BY NEGATIVE PIONS.
B.C.Barish, R.J.Kurz, P.G.McManigal, V.Perez-Mendez and J.Solomon.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 297-300 (March 15, 1961).

The reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ was was studied for incident pion energies of 365 and 432 MeV. The momentum spectra of the π^+'s resulting from the reaction were measured at 20, 50, 80 and 180 deg using a magnetic spectrometer. The differential cross-sections obtained ($d\sigma/d\Omega dT^*$) are compared with the predictions of a statistical phase-space model and show a deviation in the form of a favouring of lower momenta. This is in disagreement with the expected behaviour if a pion–pion resonance is present, but qualitatively agrees with the prediction of the ($T = \frac{3}{2}$, $J = \frac{3}{2}$) isobar model. The total cross-sections (2.07 ± 0.09 and 3.26 ± 0.14 mb for the respective energies) are also found to be larger than the predictions of static models and this, too, can be ascribed to the isobar interaction.
J.D.Dowell

8487 ON PION PRODUCTION IN A COULOMB FIELD.
B.Ferretti.
Nuovo Cimento (Italy), Vol. 19, No. 1, 193-4 (Jan. 1, 1961).

The author claims that the study of production of two pions by a pion in a Coulomb field is useful in connection with the problem of the pion–pion interaction; and states that calculations have been performed using a model in which one supposes that the interactions between pions is mainly due to a resonating state. The calculations are reported to show that the cross-section for the effect is strongly dependent on the nature of the intermediate resonating state.
J.H.Gunn

8488 EXISTENCE OF THE ω^0 PARTICLE.
R.G.Sachs and B.Sakita.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 306-7 (March 15, 1961).

Interpretations of the possible existence of a boson ω^0 with mass about 305 MeV and I = 0 or I = 1 as indicated by the recent experiments of Abashian, Booth and Crowe (Abstr. 20213 of 1960) are discussed. It is pointed out that the explanation of the ω^0 as a two-pion or three-pion state with angular momentum J = 0 or J = 1 would be inconsistent with the observed K^+ decay modes, i.e., the decay mode $K^+ \rightarrow \omega^0 + \pi^+$ should have been detected. The branching ratio for this process is estimated to be at least of the order of that for the K_{e3} decay. Other possible explanations of the ω^0 are briefly mentioned.
J.D.Dowell

8489 ANALYSIS OF THE ANOMALY IN DOUBLE MESON PRODUCTION IN p + d COLLISIONS AND THE S-WAVE PION–PION INTERACTION. Tran Nguyen Truong.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 308-9 (March 15, 1961).

The author claims that the anomaly in double pion production in p + d collisions observed by Abashian et al. (Abstr. 20213 of 1960) may be explained by a nonresonant final state interaction of the produced pion in the isospin state T = 0 instead of assuming the existence of a neutral ω^0 particle.
J.H.Gunn

8490 PION–PION INTERACTION FROM THRESHOLD ANOMALIES IN K^+ DECAY. P.Budini and L.Fonda.
Phys. Rev. Letters (USA), Vol. 6, No. 8, 419-21 (April 15, 1961).

As an example, three-pion decay of K^+ is dicsussed. The π^+ distribution would be expected to show an anomaly of order 10% in this case.
D.W.L.Sprung

8491 π–Λ RESONANCE AND THE SIGMA HYPERON.
S.Barshay and H.Pendleton,III.
Phys. Rev. Letters (USA), Vol. 6, No. 8, 421-3 (April 15, 1961).

The π–Λ zero-range formula is discussed in the light of the Dalite–Tuan phase shift solutions, the π–Λ resonance at 1385 MeV and the hypothesis that Σ is a bound π–Λ state. Some experimental predictions are made.
D.W.L.Sprung

8492 INTERACTION CROSS-SECTIONS OF HIGH-ENERGY PARTICLES. V.S.Barashenkov.
Uspekhi fiz. Nauk (USSR), Vol. 72, No. 1, 53-74 (Sept., 1960).
In Russian.

Experimental data on the interaction cross-sections of π-meso K-mesons and nucleons with nucleons are summarized and tabulate for the energy range above 0.8 BeV. The theoretical interpretation of the results is discussed in detail. [English translation in: Sovie Physics–Uspekhi (USA), Vol. 3, No. 5, 689-701 (March-April, 1961
C.J.Batt

$\pi^- + p \rightarrow \Lambda^0 + K^0$: AMPLITUDE IN THE REGION OF THE Σ^- AND Σ^0 THRESHOLDS. See Abstr. 8426

8493 CONSEQUENCE OF THE CROSSING SYMMETRY FOR A CLASS OF π–π SCATTERING DIAGRAMS.
E.Kazes.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 374-5 (April 1, 1961).

Considering only those diagrams in which the pions are absorb or created in pairs, the author obtains, from crossing symmetry, a relation between the s and p effective ranges. On combining with data on the p-wave phase shifts, this relation suggests that a large positive π–π scattering length in the τ = 0 state is inconsistent with experiment.
E.J.Squire

8494 PION–HYPERON SCATTERING.
M.M.Islam.
Nuovo Cimento (Italy), Vol. 20, No. 1, 161-71 (April 1, 1961).

A dispersion theoretic technique, suggested by Feldman, Matthews and Salam, is used to derive the static equations for pion hyperon scattering and it is shown that the inclusion of the $\bar{K}N$ channel does not change the conclusions on the $J = \frac{3}{2}$, I = 1 p-wave, π–Y resonance, given by Amati, Stanghellini and Vitale and by Capp

8495 INVESTIGATION OF THE POSSIBILITY OF A π-Λ RESONANCE IN THE CASE OF DIFFERENT PARITIES OF Λ AND Σ. F.Duimio and G.Wolters.
Nuovo Cimento (Italy), Vol. 20, No. 2, 359-65 (April 16, 1961).

In view of the recently obtained experimental information concerning energy and total angular momentum of the π–Λ resonant state (Abstr. 3240 of 1961), an analysis is made of pion–hyperon scattering based on the assumption of different parities of Λ and Σ. Since the resonance occurs in the low energy region, a fixed source field theoretic model is used. Confidence in this model is given by the fact that it leads to a good description of π–N low energy scattering. It is found that the present data are in better agreement with the authors' basic assumptions than with global symmetric assumptions.

8496 P-WAVE PION–PION RESONANCE.
A.N.Kamal.
Proc. Phys. Soc. (GB), Vol. 77, Pt 4, 917-21 (April, 1961).

A new phenomenological coupling constant in the pion–pion interaction is introduced through an interaction Lagrangian of the form

$$\mathcal{L}_{int} = \lambda_1(\phi \times \phi_{,\mu}) . (\phi \times \phi^{,\mu}).$$

It is found that this type of interaction leads to a P-wave pion–pio resonance when summation is made over the "chain-diagrams". T width of the resonance is adjusted by a cut-off and λ_1 is determine by the position of the resonance and the cut-off.

π^- SCATTERING FROM COMPLEX NUCLEI.
See Abstr. 7394

8497 THE DECAY OF STRANGE PARTICLES.
R.H.Dalitz.
"Weak Interactions", Varenna Summer School, 1959 (see Abstr. 7195 of 1961) p. 299-335.

The current understanding of K-meson and hyperon decays is reviewed. Experimental evidence is discussed as far as possible i terms of the "weak interaction current" hypothesis of Feynman and Gell-Mann. Important problems are indicated.
R.J.N.Phillip

8498 EXAMPLE OF TWO MESONS' PRODUCTION IN K^- STARS AT REST. S.Mora.
Iuovo Cimento (Italy), Vol. 18, No. 6, 1271-3 (Dec. 16, 1960).
An event found during an analysis of 4500 stars produced in hotographic emulsion by K^- mesons at rest, in which the products f the disintegration are two π -mesons and a proton of 80 MeV ogether with a recoil track. It is suggested that the event represents case of the fast capture process $K^- + p \rightarrow \pi^+ + \pi^- + \Lambda^0 + 38$ MeV, he Λ^0 becoming captured in the nucleus and subsequently under- oing non-mesonic decay. Other possible explanations are con- idered. S.J.Goldsack

8499 NEUTRAL K-MESONS. L.M.Lederman.
Weak Interactions", Varenna Summer School, 1959 (see Abstr. 195 of 1961) p. 365-73.
Describes the different behaviour expected of these particles nder strong and weak interactions, and experimental results. R.J.N.Phillips

8500 ON THE OBSERVATION OF FAST Σ-HYPERONS EMITTED FROM THE INTERACTIONS OF K^--MESONS VITH EMULSION NUCLEI. B.D.Jones, B.Sanjeevaiah, .Zakrzewski, P.G.Bizzeti, J.P.Lagnaux, M.René, M.J.Beniston, .A.Brown, E.H.S.Burhop, D.H.Davis, D.Ferreira, E.Frota-Pessoa, V.B.Lasich, N.N.Raina, M.C.Amerighi, A.Bonetti, M.Di Corato, .C.Dilworth, C.A.Fedrighini, E.Quercigh, A.E.Sichirollo and .Vegni.
Iuovo Cimento (Italy), Vol. 19, No. 6, 1077-89 (March 16, 1961).
A study of fast baryons emitted from 12 150 K^- mesons interactions t rest in emulsion was made in order to determine the nature and extent of K^- meson-multinucleon capture processes. Fast Σ yperons are produced in at least 9% of all interactions while direct ast Λ^0 hyperon production is indicated by the presence of 3 protons ith energies exceeding 200 MeV. An upper limit of 30% is obtained or multinucleon processes (not producing π mesons) from consider- tion of π meson emission. The energy spectra for fast Σ hyperons nd fast protons are given and mass determinations on a sample of o-called fast protons revealed about 10% of deuterons and tritons. he suggestion in K^- European Collaboration Pt II (Abstr. 1308 of 960) of an apparent infrequency of the reaction $K^- + n + n \rightarrow \Sigma^- + n$ s confirmed and an α-particle model of K^- meson multinucleon nteraction is put forward to explain both this and the emission of euterons and tritons.

8501 INTERACTIONS OF 1.15 GeV/c K^--MESONS IN EMULSION. II.
..M.Chiesa, B.Quassiati and G.Rinaudo.
Iuovo Cimento (Italy), Vol. 19, No. 6, 1171-82 (March 16, 1961).
For Pt I, see Abstr. 20228 of 1960. The results concern the nergy spectrum and angular distribution of the re-emitted K^-, the -meson production, the mean life-time of $\Sigma^\pm$, Σ^+ and Σ^- hyperons, he nuclear scattering of $\Sigma^\pm$ and the up-down asymmetry in the ecay of the Σ^+ hyperon.

8502 RESONANCE IN THE K—π SYSTEM. M.Alston, L.W.Alvarez, P.Eberhard, M.L.Good, .Graziano, H.K.Ticho and S.G.Wojcicki.
hys. Rev. Letters (USA), Vol. 6, No. 6, 300-2 (March 15, 1961).
Reactions of the form $K^- + p \rightarrow \bar{K}_0 + \pi^- + p$ were studied in a 5 in. hydrogen bubble chamber exposed to a 1.15 BeV/c K^- beam. 8 events were observed giving a total cross-section of .0 ± 0.3 mb. The kinetic energies of protons resulting from the nteractions show a strong peaking around a value of 20 MeV and his is interpreted as arising from a final-state K--π resonance r K^* particle: $K^- + p \rightarrow K^{*-} + p$. The mean value of the total esonance energy (or mass) of the state is 885 ± 3 MeV. After ubtraction of estimated background, 22 events lie in the region of he peak and the full width of the peak at half-height is found to be 6 MeV, corresponding to a lifetime of 4×10^{-23} sec. The angular istribution of the decay of the K^* is consistent with a spin = 0 or J = 1 but not J ≥ 2. A preliminary investigation of dditional data from the reactions $K^- + p \rightarrow K^- + \pi^0 + p$ and $^- + p \rightarrow K^- + \pi^+ + n$ also indicates resonances and a crude estimate f the branching ratio

$$R = (K^{*-} \rightarrow K^- + \pi^0)/(\bar{K}^{*-} \rightarrow \bar{K}_0 \ \pi^-)$$

s given as 0.75 ± 0.35. This agrees with a ratio of 0.5 which should ccur if the K^* has isotopic spin $I = \frac{1}{2}$. J.D.Dowell

8503 K^- ABSORPTION AND THE KΣN PARITY. R.H.Capps.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 375-7 (April 1, 1961).
The $K^- + p$ reaction at 400 MeV/c is considered for two different parity assignments; in particular the origin of the large $\cos^2\theta$ term in the angular distributions is discussed. Methods for testing the parity assignments, by studying this reaction, are suggested. E.J.Squires

8504 PARTIAL WAVE DISPERSION RELATIONS IN $\bar{K}$—NUCLEON ABSORPTION. I. R.G.Moorhouse.
Nuovo Cimento (Italy), Vol. 20, No. 1, 122-39 (April 1, 1961).
Using the double dispersion relations, the singularities of partial wave amplitudes for transitions between the coupled channels $\bar{K} + \mathcal{N}$, $\pi + \Sigma$ and $\pi + \Lambda$, are found. A formalism for solving the dispersion relations, using the unitarity condition, is written down according to the proposal of Bjorken.

8505 A MODEL FOR S-WAVE $\bar{K}$—N SCATTERING. B.H.Bransden, H.Rashid and R.G.Moorhouse.
Nuovo Cimento (Italy), Vol. 20, No. 2, 213-24 (April 16, 1961).
The importance of pair creation in the scattering of K-mesons by nucleons is investigated by means of a specific model. A model Hamiltonian is employed that allows only the elementary virtual processes $\pi \rightarrow N + \bar{N}$ and $\bar{K} \rightarrow Y + \bar{N}$ where Y stands for a hyperon N for a nucleon and π for a pion. Three coupled integral equations are obtained for the scattering amplitudes which represent an exact solution to the model problem. These equations are solved numerically and the characteristics of the model are discussed.

Hyperons

8506 HYPERON DECAY IN THE NONLEPTONIC MODE. S.Nakamura and M.Konuma.
Phys. Rev. (USA), Vol. 122, No. 5, 1620-3 (June 1, 1961).
An interaction Hamiltonian of the weak interaction between baryons and pions is described in the three-dimensional charge space. In order to determine the types of interaction, a conservation law of extended chirality is speculated; the branching ratios and absolute lifetimes of the hyperon decays on nonleptonic modes are calculated and the results are compared with experiment.

8507 THE EXCITED HYPERON AND PION--HYPERON RESONANCES. S.F.Tuan.
Nuovo Cimento (Italy), Vol. 18, No. 6, 1301-4 (Dec. 16, 1960).
Discusses qualitatively the effects of the existence of an excited hyperon in the I = 1 state in the $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ reaction at 1.15 GeV/c K^- lab. momentum. Experiments which would clarify the situation considerably are pointed out. E.A.Sanderson

8508 THE DETERMINATION OF THE SIGN OF THE ASYMMETRY PARAMETER IN Λ^0 DECAY FROM THE SCATTERING OF THE DECAY PROTON.
T.Bowen, C.R.Sun and A.E.Werbrouck.
Nuovo Cimento (Italy), Vol. 20, No. 2, 225-36 (April 16, 1961).
A statistical method is presented whereby the information provided by a small number of nuclear scatters of Λ^0 decay protons can be used to determine the sign of the asymmetry parameter due to parity non-conservation in Λ^0 decay. As an example, the analysis is applied to twenty-one proton scatters of Λ^0 hyperons decaying in the Princeton multiplate cloud chamber. Because the asymmetry to be expected in each observed nuclear scatter is small, the data do not yield a statistically significant result. However, it is argued that if each experimenter would follow a similar procedure with his data, it should be possible to combine results to determine the sign with a high degree of certainty.

8509 ODD $\Lambda\Sigma$ PARITY AND THE NATURE OF THE $\pi\Lambda\Sigma$ COUPLING. Y.Nambu and J.J.Sakurai.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 377-80 (April 1, 1961).
Eight pieces of evidence which suggest that the $\Lambda\Sigma$ parity is odd are presented. If this result is accepted, the Σ can be regarded as a bound $\pi\Lambda$ system, and it is shown how this leads to an approximate evaluation of the $\pi\Lambda\Sigma$ scalar coupling constant. The value obtained is consistent with other evidence. E.J.Squires

8510 PROPOSAL OF AN EXPERIMENT ON $\Sigma^\pm$-DECAYS. P.Meyer, J.Prentki and Y.Yamaguchi.
Nuovo Cimento (Italy), Vol. 20, No. 2, 344-50 (April 16, 1961).
A discussion is given of specific experimental conditions under which the s or p-wave nature of the decays $\Sigma^\pm \rightarrow n + \pi^\pm$ can be

determined through a study of the neutron polarization. Besides being a check of the $\Delta I = \frac{1}{2}$ rule this experiment gives a measure of Σ^+ polarizations and therefore leads to the determination of the magnitude and sign of the asymmetry coefficient α^0.

8511 FREQUENCY OF THE DECAY MODE $\Sigma^+ \rightarrow p + \gamma$.
J.Schneps and Y.W.Kang.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1218-20 (March 16, 1961).

A search was made for events which could be attributed to the rare mode of decay $\Sigma^+ \rightarrow p + \gamma$. These events in nuclear emulsion will give a proton of unique range 3045 μm. Four events were found consistent with this interpretation in a sample which contained 264 normal decays $\Sigma^+ \rightarrow p + \pi^0$. Taking into account background which could come from Σ^- one-prong stars or decays in flight of very slow Σ^+ in the normal way, the frequency of $\Sigma^+ \rightarrow p + \gamma$ is estimated to be about 1% that of $\Sigma^+ \rightarrow p + \pi^0$.

8512 LEPTONIC DECAY OF A Σ^- HYPERON.
P.Franzini and J.Steinberger.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 281-3 (March 15, 1961).

A clear example is presented of the decay of a Σ^- hyperon by the mode $\Sigma^- \rightarrow e^- + \nu + n$. The event was observed in a 30 in. propane chamber exposed to a 2 BeV π^- beam at the Brookhaven Cosmotron. J.D.Dowell

8513 CHARGED HYPERON PRODUCTION BY 16 GeV/c π^- MESONS.
J.Bartke, R.Böck, R.Budde, W.A.Cooper, H.Filthuth, Y.Goldschmidt-Clermont, F.Grard, G.R.MacLeod, A.Minguzzi-Ranzi, L.Montanet, W.G.Moorhead, D.R.O.Morrison, S.Nilsson, C.Peyrou, B.W.Powell, J.Trembley, D.Wiskott, I.Bertanza, C.Franzinetti, I.Manelli, V.Silvestrino, G.Brautti, M.Ceschia and L.Chervosani.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 303-5 (March 15, 1961).

Approximately 35 000 pictures, taken with the CERN 30 cm hydrogen bubble chamber exposed to a 16 GeV/c negative pion beam, were scanned, yielding 48 charged strange particles (28 Σ^+, 18 Σ^- and 2 K^+). After applying corrections for scanning biases the ratio of Σ^+/Σ^- production is found to be $1.8^{+0.7}_{-0.5}$ which corresponds to cross-sections of 0.35 ± 0.08 mb for Σ^+ and and 0.19 ± 0.05 mb for Σ^-. Momentum distributions for the Σ hyperons at production are given as well as their mean transverse momenta (respectively 0.54 and 0.58 GeV/c). This may be compared with the mean transverse momentum of the π-mesons produced, which is 0.33 GeV/c. The angular distributions of the hyperons are peaked backwards in the π–p centre-of-mass system. No significant difference is found between the multiplicity of jets with a charged V decay (4.4 ± 0.2) and jets where no strange particle decay was visible (4.3 ± 0.1). J.D.Dowell

8514 PROPERTIES OF THE Y* AS OBSERVED IN THE INTERACTION $K_2^0 + p \rightarrow \Lambda^0 + \pi^+ + \pi^0$.
H.J.Martin, L.B.Leipuner, W.Chinowsky, F.T.Shively and R.K.Adair.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 283-5 (March 15, 1961).

An analysis is performed to study the production of the strangeness −1, isotopic spin 1 baryon state Y^* ($\Lambda\pi$ resonance) using the reaction $K_2^0 + p \rightarrow \Lambda^0 + \pi^+ + \pi^-$ in a 14 in. hydrogen bubble chamber. 60 analysable events resulted from incident K_2^0 particles having a Gaussian momentum distribution centred at 975 MeV/c with a half-width of 100 MeV/c. The existence of the Y^* is manifested by peaks in the Q-value distributions for $(\Lambda^0\pi^+)$ and $(\Lambda^0\pi^0)$. 22 Y^+ and 18 Y^0 events lie in the region of the peak. Taking into account the experimental resolution, the width of the resonance is estimated to be ≤ 20 MeV, in contrast to the value of 63 MeV reported by Alston et al. (Abstr. 3240 of 1961). An analysis of the angular distribution of the decay products of Y^*'s produced at small angles to the beam direction tends to favour a spin assignment of $J = \frac{1}{2}$. Additional information obtained from measurements of the asymmetry of the subsequent Λ decays suggests that the Y^* is also in an S-state. The result is discussed in relation to the K^-–p scattering length solutions of Dalitz and Tuan, and the Σ–Λ relative parity. J.D.Dowell

8515 PROPERTIES OF NEUTRAL STRANGE PARTICLES PRODUCED IN A XENON BUBBLE CHAMBER.
J.L.Brown, H.C.Bryant, R.A.Burnstein, D.A.Glaser, R.Hartung, J.A.Kadyk, J.D.Van Putten, D.Sinclair, G.H.Trilling and J.C.Van der Velde.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1155-70 (March 16, 1961).

By means of direct observations of the neutral decay modes $\Lambda \rightarrow n + \pi^0$ and $K_1^0 \rightarrow \pi^0 + \pi^0$ of Λ's and K^0's produced in a 21 litre liquid xenon bubble-chamber exposed to 1.0 GeV and 1.1 GeV π^- beams at the Bevatron, branching ratios were measured

$$B_\Lambda \equiv \frac{(\Lambda \rightarrow \pi^0 + n)}{(\Lambda \rightarrow \pi^0 + n) + (\Lambda \rightarrow \pi^- + p)} = 0\ 35 \pm 0.05,$$

$$B_K \equiv \frac{(K_1^0 \rightarrow \pi^0 + \pi^0)}{(K_1^0 \rightarrow \pi^0 + \pi^0) + (K_1^0 \rightarrow \pi^- + \pi^+)} = 0.30 \pm 0.035,$$

in agreement with predictions of the $|\Delta I| = \frac{1}{2}$ rule. The fraction of all K^0's which did not decay into $\pi^+ + \pi^-$ or $\pi^0 + \pi^0$ in a time of the order of 10^{-10} sec is $X_k = 0.47 \pm 0.03$, as expected from the particle mixture description of the K^0. Λ's produced in xenon exhibit an "up–down" asymmetry associated with a polarization of the Λ normal to the production plane, although this polarization is not as great as that observed for Λ's produced by similar beams in hydrogen. No significant forward–backward decay asymmetry of the Λ with respect to its own line of flight is found. Strange particle production cross-sections in xenon are reported.

Deuterons

8516 PROTONS FROM THE p + d BREAKUP REACTION AT PROTON ENERGIES OF 14 MeV AND 10 MeV.
S.Kikuchi, J.Sanada, S.Suwa, I.Hayashi, K.Nisimura and K.Fukunaga.
J. Phys. Soc. Japan, Vol. 15, No. 5, 749-53 (May, 1960).

The energy spectra were measured as a function of angle for the incident proton energies of 13.9 MeV and 10.1 MeV, using a particle selecting counter telescope consisting of a three- or five-layer proportional counter for the energy loss measurement and of an NaI scintillation counter for the energy measurement. Each of the observed energy spectra shows a rather steep rise at the maximum energy followed by a slight shoulder at large angles at the incident proton energy of 14 MeV, while the energy spectra at small angles do not show such a shoulder. For both energies, each of the spectra has a maximum in its low energy side.

8517 DOUBLE DISPERSION RELATIONS FOR DEUTERON PHOTO- AND ELECTRODISINTEGRATION.
A.Martin and R.Vinh Mau.
Nuovo Cimento (Italy), Vol. 20, No. 2, 246-64 (April 16, 1961).

The deuteron photodisintegration matrix element, which exhibits in the relativistic case, anomalous thresholds is studied in the nonrelativistic case, where the nucleons interact through a superposition of Yukawa or exponential potentials. For simplicity all spins are taken to be zero. A double dispersion relation is derived in agreement with the latest results of Eden et al. The treatment is easily extended to electrodisintegration.

8518 PROTON ANGULAR DISTRIBUTIONS FROM d + D REACTION FOR DEUTERON ENERGIES 0.5-0.9 MeV.
Z.Sawa.
Ark. Fys. (Sweden), Vol. 18, Paper 24, 365-8 (1960).

Experiments were carried out in an attempt to obtain a more complete picture of the behaviour of the energy dependent asymmetry coefficients in the theoretical angular-distribution expression The proton angular distributions are plotted in relative units as a function of Θ^0 and E_d. Curves drawn are the best fit of the expression

$$d\sigma = \text{const.}[1 + A(E).\cos^2\theta + B(E).\cos^4\theta]\,d\Omega$$

to the experiment points. There is no serious discrepancy between these results and others obtained at deuteron energies less than 0.6 MeV and greater than 0.9 MeV. The results also show no rapid change in the distribution which would indicate other contributions due to the Coulomb or nuclear distortion effects on incoming or outgoing waves. It is further stated that the expression quoted for $d\sigma$ fits the experimental points better than stripping curves do. B.Brown

8519 DEUTERON–DEUTERON [ELASTIC] SCATTERING WITH ALLOWANCE FOR THEIR MUTUAL DISTORTION
G.Ernst and S.Flugge.
Z. Phys. (Germany), Vol. 162, No. 5, 448-67 (1961). In German.

Integro-differential equations are derived to deal with the scattering phenomenon at low energies of a few MeV. The mutual distortion of the two deuterons at close distance turns out to have a large influence on the angular distribution. A simple and plausible assumption is made concerning this distortion, and the results are compared with experiment for two energies.

Tritons

8520 ANGULAR DISTRIBUTIONS OF T(p,n)He^3 NEUTRONS FOR 3.4 TO 12.4 MeV PROTONS.
M.D.Goldberg, J.D.Anderson, J.P.Stoering and C.Wong.
Phys. Rev. (USA), Vol. 122, No. 5, 1510-13 (June 1, 1961).

Neutron angular distributions were obtained for incident laboratory proton energies of 3.4, 4.3, 5.0, 6.5, 8.0, 8.8, 10.3, 11.5 and 12.4 MeV. The neutrons were detected by a plastic scintillator, and standard time-of-flight techniques were used to separate the monoenergetic neutron group from background neutrons and gamma rays. The distributions in the centre-of-mass system show substantial backward peaking. Above about 8 MeV proton energy, a broad maximum appears at about 80° (c.m.) and persists through the highest energy measured. The absolute 0° cross-sections and the total integrated cross-sections are in excellent agreement with previous measurements.

Alpha-particles

8521 He^3 + He^3 ELASTIC SCATTERING.
J.L.Gammel, J.E.Brolley, Jr, L.Rosen and L.Stewart.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 8153 of 1961) p. 215-17.

Differential scattering cross-sections for the He^3 + He^3 elastic scattering process were measured at laboratory He^3 energies of 20 and 25 MeV with a multiplate nuclear camera and the Los Alamos cyclotron. A phase-shift analysis of the data is made.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

8522 PRIMARY COSMIC-RAY α-PARTICLES. I.
A.Engler, M.F.Kaplon, A.Kernan, J.Klarmann, C.E.Fichtel and M.W.Friedlander.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1090-9 (March 16, 1961).

The primary cosmic-ray α-particle energy spectrum was investigated, using photographic emulsions flown from Minneapolis on July 30th, 1957. The total flux observed was (151 ± 9) particles/m^2 sr sec. The differential energy spectrum shows a broad maximum between 400 and 600 MeV/nucleon, and appears different in shape from the spectrum observed at solar minimum. No particles were observed to have kinetic energies below 200 MeV/nucleon, but a substantial flux was observed between 200 and 300 MeV/nucleon. From the centred dipole approximation to the geomagnetic field, one would expect a cut-off energy at this latitude of 492 MeV/nucleon. The results presented are in disagreement with this figure, but do not allow a choice to be made between cut-off energies predicted from other models.

8523 THE HEAVY COMPONENT OF THE PRIMARY COSMIC RADIATION DURING SOLAR MAXIMUM.
C.E.Fichtel.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1100-15 (March 16, 1961).

This was studied at geomagnetic latitude 55° N. The total flux was found to be down by a factor of about two, compared to the results obtained during solar minimum, but the charge spectrum was found to be the same, to within experimental errors. The extrapolated fluxes at the top of the atmosphere were found to be: (3.08 ± 0.64) part./m^2 sr sec for $3 < Z < 5$; (8.26 ± 0.82) part./m^2 sr sec for $6 < Z < 9$; and (2.96 ± 0.49) part./m^2 sr sec for $10 < Z$. When this work was combined with that of other experimentalists obtained at different latitudes and compared to the data obtained at solar minimum, the change in the integral spectrum was found to be in fair agreement with the predictions of an electric acceleration modulating mechanism.

8524 CLOUD-CHAMBER OBSERVATIONS OF PRIMARY COSMIC-RAY ELECTRONS. J.A.Earl.
Phys. Rev. Letters (USA), Vol. 6, No. 3, 125-8 (Feb. 1, 1961).

In a multiplate cloud chamber flown to pressure altitude 4.5 g cm^{-2}, 11 events were observed which were identified as electrons of energy 0.5-3.0 GeV, on the basis of the development of the electromagnetic cascade. A correction for secondary particles is computed at 1.5 ± 0.4 events, from the observed γ-ray initiated showers. The ratio of electrons to protons in the primary flux is derived as 3 ± 1%. N.A.Porter

8525 SATELLITE DETERMINATION OF HEAVY PRIMARY COSMIC-RAY SPECTRUM.
M.A.Pomerantz, S.P.Agarwal, P. Schwed and H.Hanson.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 362-4 (April 1, 1961).

The value of γ in the integral magnetic rigidity spectrum: $N(>pc/ze) = k(pc/ze)^{-\gamma}$, for primary nuclei with $Z \geq 6$, was measured with a pulse ionization chamber, carried in the satellite Explorer VII. The value of γ is determined for two magnetic field approximations; for a centred dipole it was 0.91 ± 0.07 in Oct. 1959, and 0.80 ± 0.07 in April 1960. Using the Quenby–Webber model (Abstr. 15492 of 1960), it was 0.89 ± 0.07 in Oct. 1959, and 0.90 ± 0.06 in April 1960. It is concluded that the derived value of γ may be dependent on the field model used, for localized measurements, but under global sampling the effect of the model is not significant. N.A.Porter

8526 NOTE ON ENDING PARTICLES IN NUCLEAR EMULSIONS EXPOSED TO THE PRIMARY COSMIC RADIATION. C.J.Waddington.
Nuovo Cimento (Italy), Vol. 18, No. 4, 820-2 (Nov. 16, 1960).

Measurements of the number of tracks stopping/cm^3 hour, are given for 17 emulsion stacks, flown between 1954 and 1959; and compared with the geomagnetic cut-off rigidity and neutron intensity at sea level. A relation derived previously (Abstr. 13092 of 1960) for solar minimum still appears valid, but fluctuations since 1957 are larger than those previously found. The importance of control emulsions, or of detailed knowledge of the history of each emulsion, is stressed. N.A.Porter

SYMPOSIUM ON THE JULY 1959 EVENTS AND ASSOCIATED PHENOMENA, HELSINKI, JULY 1960. See Abstr. 7988

SUDDEN EXPANSION OF THE CORONA FOLLOWING A LARGE SOLAR FLARE AND THE ATTENDANT MAGNETIC FIELD AND COSMIC-RAY EFFECTS. See Abstr. 7995

COSMIC-RAY FLARE OF NOVEMBER 20, 1960.
See Abstr. 7999

8527 INFLUENCE OF GEOMAGNETIC FIELD ON EXTENSIVE AIR SHOWERS OF COSMIC RADIATION.
A.Bhaskara Rao and P.S.Gill.
Indian J. Phys., Vol. 34, No. 4, 153-8 (April, 1960).

Cocconi [(Abstr. 5759 of 1954), and Phys. Rev. (USA), Vol. 94, 796; Vol. 95, 1705 (1954)] pointed out that the deflection of air shower particles in the earth's magnetic field should produce some ellipticity of shower structure, and hence the lateral distribution of electrons around the shower axis should not be circular, but elliptical, with the major axis in the East–West direction. This effect was investigated at Gulmarg (alt. 2710 m, 24° 36' N geomagnetic lat.) with two G.M. counter telescopes, for three separations 10 m, 25 m, and 40 m. The results show that there is a significant difference between the shower rates from East–West and North–South directions. This asymmetry in the shower rates is found to increase with the separation, and the zenith angle of the telescopes.

8528 STUDIES ON EXTENSIVE AIR SHOWERS.
II. SEA LEVEL OBSERVATIONS ON THE FLUCTUATIONS IN THE DENSITIES OF N-PARTICLES, IN SHOWERS OF THE SAME SIZE. B.K.Chatterjee, G.T.Murthy, S.Naranan, B.V.Sreekantan and M.V.Srinivasa Rao.
Nuovo Cimento (Italy), Vol. 20, No. 2, 237-45 (April 16, 1961).

For Pt I, see Abstr. 5805 of 1961. A study of the fluctuations in the densities of N-particles in extensive air showers was carried out with a set-up consisting of five N-detectors located at the centre of an array of scintillators. Air showers were grouped according to their size and the distance of the core from the N-detectors. In each group of showers of given size and core distance the observed frequency distribution in the number of N-detectors activated, shows the existence of large fluctuations in the densities of N-particles.

MEASUREMENT OF THE COLLISION MEAN FREE PATH OF PENETRATING SHOWER PRODUCING COSMIC RAY NEUTRONS IN LEAD. See Abstr. 8460

8529 THE EFFECTIVE DIRECTIONAL SENSITIVITY OF COSMIC-RAY NEUTRON MONITORS.
S.M.Lapointe and D.C.Rose.
Canad. J. Phys., Vol. 39, No. 5, 668-76 (May, 1961).

The direction of maximum sensitivity of a neutron monitor is calculated numerically for a set of points on the same geomagnetic meridian but extending in latitude from the equator to the pole. This leads to two master curves, one for the longitude, the other for the latitude of this direction. From these curves this direction is obtained in geographic co-ordinates for some 20 cosmic-ray stations. The method of calculation is described taking into account atmospheric absorption and the energy spectrum of the incident particles. The aperture of the sensitive cone, or source width, is also calculated. Finally the accuracy of the results is discussed and the application of the concept of effective direction is described.

NUCLEUS

8530 OPEN PROBLEMS [IN NUCLEAR STRUCTURE]. I.
R.E.Peierls.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 7-19.

8531 OPEN PROBLEMS [IN NUCLEAR STRUCTURE]. II.
A. SOME STRUCTURE PROBLEMS CHIEFLY IN THE LIGHT NUCLEI.
B. THE NUCLEAR SURFACE.
C. NUCLEAR STRUCTURE EXPERIMENTS AT MEDIUM ENERGIES.
D. ELEMENTARY PARTICLES IN NUCLEAR STRUCTURE STUDIES.
D.H.Wilkinson.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 20-4, 24-46, 46-64, 65-6.

8532 THE PROPERTIES OF NUCLEAR FORCES WHICH ARE RELEVANT TO NUCLEAR STRUCTURE.
K.A.Brueckner.
Nuclear structure conference, Kingston, Ontario,1960 (see Abstr. 2153 of 1961) p. 67-73; Disc., 73-5.

8533 THE STRUCTURE OF NUCLEAR MATTER.
C.Bloch.
Nuclear structure conference, Kingston, Ontario,1960 (see Abstr. 2153 of 1961) p. 76-85; Disc., 85-9.

8534 MODELS OF FINITE NUCLEI.
A.de Shalit.
Nuclear structure conference, Kingston, Ontario,1960 (see Abstr. 2153 of 1961) p. 90-103; Disc., 103-9.

8535 THE PROPERTIES OF FINITE NUCLEI.
K.A.Brueckner.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 110-16; Disc., 116-17.

Reports studies of the properties of O^{16}, Cd^{40} and Zr^{90} using the Brueckner—Gammel—Weitzner theory. The local and nonlocal Hartree—Fock potentials are shown for Zr, and the proton, neutron and total density as a function of radius for all three nuclei. The binding energies are too small by 2 or 3 MeV per particle, and the radii are also somewhat too small. E.J.Burge

8536 ON THE COLLECTIVE EXCITATIONS IN SUPERFLUID NUCLEAR MATTER. B.B.Dotsenko.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 118-24.

The method of Bogolyubov (Abstr. 2714 of 1961) is used to determine the energetics of the ground state and excited states. For the assumptions made, there appear to be two types of collective excitations, a "normal" type of about 30 MeV (Abstr. 4970 of 1959) and excitations of the superfluid phase (< 1 MeV) for the case of weak perturbations. E.J.Burge

8537 NUCLEAR DEFORMATION AND NUCLEAR FORCE.
K.Ikeda, S.Nagata and K.Takada.
Nuclear structure conference, Kingston, Ontario,1960 (see Abstr. 2153 of 1961) p. 124-6.

Nuclear deformation of the rotational nuclei Mg^{24} is determined by the variational method. The Hamiltonian is essentially that of Brueckner's shell model space, and the trial wave-function is Nilsson's. The main contribution to the deformation comes from central forces, and the role of spin—orbit and tensor forces for the deformation is shown qualitatively.

8538 REARRANGEMENT AND THE BARRIER AT THE EDGE OF A NUCLEUS. D.R.Inglis.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2158 of 1961) p. 126-8.

The energy Δ gained by rearrangement of the other nucleons when one nucleon is adiabatically separated means that the barrier height confining shell-model wave functions is higher by Δ than the separation energy E_S, used conventionally. This is related to the surprising success of oscillator functions. Levels with small E_S have small Δ and may still be depressed.

8539 VELOCITY-DEPENDENT SINGLET POTENTIALS.
M.Razavy, O.Rojo and J.S.Levinger.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 128-30.

Observed phase shifts for proton—proton scattering in the ^1S state are fitted with a well-behaved, velocity-dependent potential of the form $-V_0J_1(r) - (\lambda/M)\vec{p}.J_2(r)\vec{p}$, where $\vec{p}$ is the quantum-mechanical operator. Two examples are treated: $J_1 = J_2$ = a square well; and J_1 of Yukawa shape combined with J_2 of exponential shape.

8540 NUCLEAR MODEL SUGGESTED BY THE MANY-BODY PROBLEM IN ONE DIMENSION. T.Sasakawa.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2158 of 1961) p. 130-3.

To get an insight into the structure of nuclear matter, the many-body system in one dimension is solved exactly. The wave-function obtained represents the nature of a liquid rather than a gas, showing the saturation of density and binding energy. It shows strong opposition to the Fermi gas model, as the zeroth approximation for nuclear matter.

8541 SOME CONSIDERATIONS ON THE STRUCTURE OF NUCLEAR MATTER. L.E.H.Trainor.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 133-4.

Traditionally, nuclear matter has been treated as a many-nucleon problem. A new approach is to inquire into the state of the π-meson field in the many-nucleon system. For this purpose, a meson-atomic model of the nucleon is devised and the method of Wigner and Seitz is adapted from solid state theory to investigate the problem.

8542 FOUNDATIONS OF THE OPTICAL MODEL AND DIRECT INTERACTIONS. G.E.Brown.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 135-41; Disc., 141-5.

8543 THE PARAMETERS OF THE OPTICAL MODEL POTENTIAL AND THEIR PHYSICAL INTERPRETATION.
D.S.Saxon.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 197-208; Disc., 208-11.

8544 SHELL EFFECTS IN THE OPTICAL POTENTIAL.
A.Sugie.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 237-9.

It is shown that the imaginary part of the optical potential may depend on the mass number due to the shell effect. Importance of the parity conservation law in the scattering process leading to the compound state is pointed out in addition to the shell effect of the single-particle excitation spectrum. Reference to the experimental values of R' and Γ/D for A = 60-80 and 90-130 is made.

8545 DETERMINATION OF NUCLEAR SURFACE PARAMETERS BY MEANS OF THE ELASTIC SCATTERING OF LIGHT NUCLEI.
J.A.McIntyre, K.H.Wang and S.D.Baker.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 384-7.

The elastic scattering processes, $Pb^{208}(O^{16},O^{16})Pb^{208}$ and $Tb^{159}(F^{19},F^{19})Tb^{159}$ were studied experimentally. An analysis of the data using a smoothed modification of the Blair sharp cut-off approximation shows that the nuclear surface "thickness" is approximately three times as large for the Tb^{159} case as for the Pb^{208} case.

8546 THE SHELL MODEL AND ITS EFFECTIVE NUCLEAR FORCES. J.P.Elliott.
iclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 419-26; Disc., 426-8.

8547 CONFIGURATION MIXING AND THE EFFECTS OF DISTRIBUTED NUCLEAR MAGNETIZATION ON YPERFINE STRUCTURE IN ODD A NUCLEI.
H.Stroke and R.J.Blin-Stoyle.
iclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 518-21.

The effect of nuclear moment (μ) distribution of h.f.s. (ϵ) lculated by using the configuration-mixing theory of Blin-Stoyle bstr. 1568 of 1954) and Arima and Horie (Abstr. 4872 of 1955). ne necessary electron solutions of the Dirac equation were tained for a Hofstader charge distribution. Generally, the theory rees with experiment, the formalism also permits a semi- enomenological treatment, whereby the dominant admixtures are duced from the experimental values of μ and ϵ.

8548 AN EXTENSION OF THE SHELL MODEL FOR HEAVY SPHERICAL NUCLEI. M.Baranger.
iclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 584-6.

The Bardeen—Bogolyubov—Belyaev treatment of pairing rrelations is applied to spherical nuclei with a general nuclear rce. The interaction between quasi-particles is treated by the ethod of linearized equations of motion. The method holds both r collective and single-particle excitations. It is at least as werful as other treatments of collective effects starting from e shell model.

8549 SPINS OF THE ISOMERIC STATES OF Hf^{178} AND Hf^{180}. M.Deutsch and R.W.Bauer.
iclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 592-3.

Angular correlations and internal conversion unambiguously tablish J = 8(-) for both states.

8550 ON THE CORRELATION BETWEEN THE NUCLEAR DEFORMATION AND THE MOMENT OF INERTIA.
.Elbek.
iclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 601-3.

Recent data from lifetime measurements and Coulomb excit- ion yield accurate information on the nuclear deformation. A rong correlation between the deformation and the nuclear moment inertia is found, but the correlation is different for the rare rths and for the heavy elements. A new method developed by endenning and Sawicki (UCRL Report 9178) for determination of e deformation seems to bring all data in agreement.

8551 MOMENTS OF INERTIA OF ODD NUCLEI.
Yu.T.Grin', S.I.Drozdov and D.F.Zaretskii.
iclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 616-17.

The method developed by Migdal (Abstr. 9505 of 1960) is used calculate the moments of inertia of odd nuclei. No results are oted. E.J.Burge

8552 ON THE NON-AXIAL DEFORMATION OF THE MEDIUM AND HEAVY EVEN—EVEN NUCLEI.
Hiura and S.Suekane.
iclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 620-3.

These nuclei are divided into two groups by the parameter γ_0 of dial asymmetry. One group, corresponding to a rotational region, s $\gamma_0 \sim 10^0$, and the other, corresponding to a so-called vibrational gion, has $\gamma_0 \sim 26^0$. Transition between these two groups is very pid but continuous. The relation between the asymmetry in the odels of Gottfried (Abstr. 8920 of 1956) and of Davydov and llipov (Abstr. 1722 of 1959) is discussed.

8553 VARIATION OF NUCLEAR MOMENTS OF INERTIA WITH DEFORMATION. N.MacDonald.
iclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 630-2

The dependence of nuclear moments of inertia on β is dis- ssed in connection with (a) the improvement of the hydrodynamical timate of the rotation—vibration correction to rotational energies, d (b) the explanation, in terms of an asymmetric nucleus, of the npirical rule $B(E2) \propto E_2^{-m}$ ($m \sim 1.2$) for the first excited state of ny even nuclei. In particular, Sm^{152} is discussed in (a) and W, in (b).

8554 CONCERNING THE MAGNETIC MOMENTS OF DEFORMED NUCLEI. J.O.Rasmussen and L.W.Chiao.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 646-9.

A comparison of experimental and calculated magnetic moments of odd-A spheroidal nuclei gives strong evidence that there is a reduction of the magnitude of the effective g_S factors by ~ 1.5 units below the magnitudes for free nucleons. The seriousness of Coriolis interaction effects on μ for one class of nuclei is also illustrated.

8555 MOTION OF NUCLEONS IN AN ANISOTROPIC OSCILLATOR POTENTIAL TAKING THE SPIN—ORBITAL INTERACTION INTO ACCOUNT.
D.V.Volkov and E.V.Inopin.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 652-4.

The general case of three different frequencies of the oscillator potential is considered. The spin—orbit interaction leads to a de- crease in the departure from axial symmetry. E.J.Burge

8556 RESIDUAL INTERACTION AND THE DEFORMATION OF NUCLEI. A.Arima.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 69-83 (April, 1961).

The influence of short-range (delta-function) two-body inter- actions on the equilibrium deformation of nuclei at the beginning of the (2s–1d) shell was studied. The moment of inertia, the equilibrium deformation, and the energy of β vibrations, were calculated as a function of the strength of the interaction.

8557 AN EXTENSION OF THE OVERHAUSER MODEL FOR NUCLEAR MATTER. E.M.Henley and T.W.Ruijgrok.
Ann. Phys. (USA), Vol. 12, No. 3, 409-25 (March, 1961).

Overhauser proposed a single-particle trial wave-function for the ground state of a system of Fermi particles with attractive two-body point interactions. This problem was re-investigated for the case of finite range attractive and repulsive two-body forces. It is shown that the magnitude of the energy gap above the ground- state is diminished or disappears completely; the spatial density variations for both spin directions are smaller than for a point interaction. The two density functions oscillate in phase when the two-body potential is attractive and in phase-opposition for repulsive forces. For certain potentials a Hartree--Fock ground state can be constructed which has a lower energy than that obtained with simple Overhauser wave-functions. This ground state has a region in momentum space, inside the Fermi sea, which is not occupied by any particles. However, for reasonable strengths and ranges of the two-body force the Overhauser ground state is the lowest one obtained and an energy gap occurs.

8558 ON THE SPIN DEPENDENCE OF NEUTRON STRENGTH FUNCTIONS. K.K.Seth.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 169-75 (April, 1961).

The possibility of J dependence of s-wave neutron strength function S is examined empirically, (a) by comparing adjoining odd-mass ($I \neq 0$) and even ($I = 0$) nuclei, (b) by requiring that the strength function should vary smoothly with atomic weight for adjoining odd-mass nuclei with different spins, and (c) by compar- ing the average reduced widths for the various isotopes of uranium. It is concluded that S_J is proportional to $(2J + 1)^{-1}$, and therefore that the optical potential should have a contribution which is dependent on target spin.

8559 EFFECTS OF CENTRE-OF-MASS MOTION IN THE NUCLEAR SHELL MODEL ON SCATTERING PROBLEMS. F.C.Barker and L.J.Tassie.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1211-17 (March 16, 1961).

The nuclear shell model does not describe correctly the motion of the centre of mass of the nucleus. The correction due to this is con- sidered for scattering problems, and especially for the scattering of high-energy electrons. Included are the interaction of the electrons with the nuclear current and magnetization densities as well as with the charge density. The correction is obtained only for the harmonic- oscillator shell model.

8560 VIBRATIONS OF SPHERICAL NUCLEI.
G.E.Brown, J.A.Evans and D.J.Thouless.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 1-17 (April, 1961).

The particle—hole interaction is discussed as the mechanism for producing vibrational states in nuclei. The procedure is first illustrated by means of a schematic model, from which it is shown that the usual type of shell-model calculation must be extended to

include correlations in the ground state of the nucleus before it can be applied to the calculation of vibrational states. Results of calculations in j–j coupling, but with zero-range forces, are given.

8561 A ROTATIONAL MODEL FOR Fe^{57}. R.D.Lawson and M.H.MacFarlane.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 18-27 (April, 1961).

A model of Fe^{57} is examined, in which the odd neutron is considered to move in the field of an axially symmetric rotor. The effect of band mixing is included. For a prolate deformation with δ from 0.15 to 0.2, reasonable agreement with experiment is obtained for many of the properties of the states below 1 MeV in Fe^{57}. However properties which depend on the intrinsic wave function of the $\frac{1}{2}^-$ ground state are in serious disagreement with experiment. The predictions of the model are insensitive to reasonable changes in the moment of inertia of the rotor and in the parameters (other than the deformation) characterizing the shape of the Nilsson potential.

8562 FORMATION OF ALPHA CLUSTERS IN EVEN–EVEN NUCLEI. F.C.Chang.
Phys. Rev. Letters (USA), Vol. 6, No. 8, 414 (April 15, 1961).

It is shown that, owing to the pairing energy in nuclei being proportional to $2j + 1$ for pairs in a j-shell, it is to be expected that alpha clusters of lower angular momentum are more probable in a nucleus. A.M.Green

8563 ON THE PAIRING ENERGY OF MEDIUM HEAVY NUCLEI. H.Kümmel.
Z. Naturforsch.(Germany), Vol. 16a, No. 2, 208-9 (Feb., 1961).

Demonstrates that experimental neutron pairing energies, for nuclei with $82 \leq N \leq 126$, are on the whole consistent with the Belyaev superfluidity theory. R.J.N.Phillips

8564 CONCERNING THE CALCULATION OF THE NUCLEAR MOMENT OF INERTIA. S.T.Beliaev.
Nuclear Phys. (Internat.), Vol. 24, No. 2, 322-5 (April, 1961).

Using the generalized method of canonical transformation an expression for the nuclear moment of inertia is found with allowances for nucleon pairing. The result in the main coincides with that obtained by Migdal (see Abstr. 4011 of 1960) by the Green's function method.

8565 AN ABSOLUTE DETECTOR AND PRODUCER OF NUCLEAR ALIGNMENT.
B.A.Jacobsohn and R.M.Ryndin.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 505-9 (May, 1961).

For a special type of reaction in which particles of spin one are absorbed or emitted, the consequences of parity and angular momentum conservation are shown to be especially simple and purely geometrical in nature. Such a reaction can serve as an absolute detector of deuteron alignment, as a source of aligned deuterons, or, when followed by a gamma ray, as a source of 100% linearly polarized photons. Some applications are given.

8566 SPIN AND HYPERFINE STRUCTURE OF ARSENIC-76. R.L.Christensen, D.R.Hamilton, H.G.Bennewitz, J.B.Reynolds and H.H.Stroke.
Phys. Rev. (USA), Vol. 122, No. 4, 1302-16 (May 15, 1961).

Hyperfine structure in the $^4S_{3/2}$ ground state of the radioactive atom As^{76} was investigated by the method of magnetic resonance in an atomic beam produced by microwave discharge dissociation of arsenic vapour. $\Delta F = 0$ resonances were observed within both the $F = \frac{5}{2}$ and $F = \frac{7}{2}$ atomic levels at several values of magnetic field up to about 5 Oe, indicating that the spin of the As^{76} nucleus is 2. An analysis of multiple quantum transition spectra within the same F states gave a measurement for two of the h.f.s. intervals: $\Delta\nu_{7/2,5/2} = \pm(117 \pm 4)$ Mc/s and $\Delta\nu_{5/2,3/2} = \pm(69 \pm 16)$ Mc/s, with the same sign for both. From the value of the h.f.s. constant A, the magnitude of the magnetic field at the arsenic nucleus is $(1.33 \pm 0.15) \times 10^5$ Oe in reasonable agreement with the variation in this field among similar atoms. The value of g_J was found to be 1.994 ± 0.003 for arsenic.

8567 NUCLEAR MOMENTS AND ISOTOPE SHIFTS IN Tl^{199}, Tl^{200}, Tl^{201}, Tl^{202}, and Tl^{204} — ISOTOPE SHIFTS IN ODD–ODD NUCLEI. R.J.Hull and H.H.Stroke.
Phys. Rev. (USA), Vol. 122, No. 5, 1574-5 (June 1, 1961).

The hyperfine-structure separations and isotope shifts of several radioactive isotopes of thallium were measured by optical spectroscopic techniques. The results are: $\mu^{199} = 1.57$ n.m.; $\mu^{201} = 1.58$ n.m.; and both $|\mu^{200}|$ and $|\mu^{202}| \leq 0.15$ n.m. The isotope shift measurements, which include the first data of this kind obtained for heavy odd–odd nuclei, permitted a comparison of the relative isotope shifts for isotones in mercury and thallium. A marked similarity in the shifts was observed.

8568 THE GYROMAGNETIC RATIO OF THE 137 keV ROTATIONAL LEVEL OF Os^{186}. E.Bodenstedt, H.J.Körner, G.Strube, C.Günther, J.Radeloff and E.Gerdau.
Z. Phys. (Germany), Vol. 163, No. 1, 1-16 (1961). In German.

The rotation of the angular correlation of the 631 keV–137 keV γ–γ cascade in the decay of Re^{186} in an external magnetic field of 53 500 G was determined as $\omega\tau = 0.098 \pm 0.008$. The half-life of the 137 keV level was measured as $T_{1/2} = (0.84 \pm 0.03) \times 10^{-9}$ sec. The coincidences between the 137 keV γ-radiation and the β-group of 927 keV maximum energy were used in connection with a time to pulse height converter circuit. The coefficients of the angular correlation of the 631 keV–137 keV γ–γ cascade were found to be $A_2 = -0.073 \pm 0.010$; $A_4 = +0.310 \pm 0.014$. These values imply corrections for 3.9% admixture of internal bremsstrahlung and a 1% contribution by K X-radiation. The solid angle-corrections were made according to the formula given by Rose. Comparison with the theoretical coefficients for a $(2^+\ 2^+\ 0^+)$ cascade shows that the multipolarity of the 631 keV radiation is pure E2, the M 1 admixture being less than 0.1%. This result is in agreement with the K-selection rule. There is no appreciable attenuation by internal fields. The comparison with the theoretical angular correlation gives for the integral attenuation factor $G_4 = 0.95 \pm 0.04$. Assuming only attenuation by electric quadrupole interaction one gets $G_2 = 0.92 \pm 0.07$. The nuclear g-factor of the 137 keV rotational state was derived from these results, without any further correction, as $g_R = +0.316 \pm 0.028$.

HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF PROTACTINIUM 233. See Abstr. 7434

THE NUCLEAR QUADRUPOLE MOMENT OF Co^{59}.
See Abstr. 7437

DETERMINATION OF NUCLEAR CHARGE DISTRIBUTION BY COMBINED USE OF ELECTRON AND POSITRON SCATTERING.
See Abstr. 8702

8569 INTERNAL CONVERSION FROM RESONANCE ABSORPTION.
H.Frauenfelder, D.R.F.Cochran, D.E.Nagle and R.D.Taylor.
Nuovo Cimento (Italy), Vol. 19, No. 1, 183-5 (Jan. 1, 1961).

The Mössbauer re-emission spectrum in Fe^{57} was observed by exploiting the large internal conversion followed by emission of K X-rays (6.3 keV), the spectrum of which reveals peaks corresponding to resonant absorption of the 14.4 keV γ-rays. E.A.Sanderson

INTERNAL FIELDS IN IRON GARNETS, USING THE MÖSSBAUER EFFECT IN Fe^{57}. See Abstr. 7769

NUCLEAR ORIENTATION OF PARAMAGNETIC IMPURITY IONS. See Abstr. 7518

8570 Λ BINDING IN HYPERNUCLEI BY NONLOCAL INTERACTION. G.Rajasekaran and S.N.Biswas.
Phys. Rev. (USA), Vol. 122, No. 2, 712-18 (April 15, 1961).

The characteristics of the Λ–N interaction at low energy are obtained assuming that the Λ–N potential is nonlocal but separable and similar to that suggested by Yamaguchi in the case of N–N potential. The unknown parameters entering in the proposed potential are determined on the basis of the global symmetry hypothesis of the strongly interacting particles. This model predicts, in agreement with Dalitz and Downs' phenomenological findings (1958-9) of the nature of the Λ–N potential based on hyperfragment data, that there is no bound Λ–nucleon system and that the singlet Λ–N potential is stronger than the triplet potential, both being attractive. Binding energies of the Λ-particle in light hypernuclei based on the present model are, however, much too high compared with the experimental data. It is further pointed out that although the global symmetry hypothesis ($g_{\Lambda\pi} = g_{\Sigma\pi} = g_{N\pi}$) supplemented by the Yamaguchi type nonlocal Λ–N potential is incompatible with the presently existing data, the restricted symmetry ($g_{\Lambda\pi} = g_{\Sigma\pi} \neq g_{N\pi}$) model is certainly admissible.

nergy Levels

8571 THRESHOLD STATES OF NUCLEI.
A.I.Baz.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 341-2.

The properties of systems with energies near two-particles resholds are considered in terms of a static potential for the ucleon—nucleus interaction and compared with experimental data or (γ,n) and (γ,p). E.J.Burge

8572 ANALYSIS OF ENERGY LEVELS IN Na^{24}.
F.A.El-Bedewi and M.A.El-Wahab.
uclear structure conference, Kingston, Ontario, 1960 see Abstr. 2153 of 1961) p. 362-4.

Magnetic analysis of the protons emitted at 10°-60° from the eaction $Na^{23}(d,p)Na^{24}$ revealed 20 proton groups. Spin and parity ssignments based on Butler's formula are made for several levels. E.J.Burge

8573 NUCLEI IN THE 1p SHELL AND NEAR CLOSED SHELLS [PROPERTIES OF INDIVIDUAL LEVELS]. E.B.Paul.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 403-16; Disc., 416-18.

8574 SYSTEMATICS OF NUCLEI BETWEEN O^{16} AND Ca^{40}.
H.E.Gove.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 438-60.

8575 INTERMEDIATE COUPLING CALCULATIONS IN THE 2s—1d SHELL. M.K.Banerjee.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 461-7.

Reports work by Levinson, Meshkov and Pal on a new method or intermediate coupling shell model calculations in the s–d shell. his allows relatively simple evaluations of the matrix elements of ny arbitrary two-body interaction potential between n-particle ave-functions of SU_3 representation by the use of the properties of ie group operators. Preliminary second-order perturbation alculations for Mg^{24} are reported. E.J.Burge

8576 AN INVESTIGATION OF THE LEVELS OF P^{30}.
E.Baart, L.L.Green and J.C.Willmott.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 468-9.

A study of the energy levels of P^{30} was made using the $i^{29}(p,\gamma)P^{30}$ reaction, and employing large sodium iodide crystals. ecay schemes are deduced, and spins and parities are assigned n the basis of angular distribution and triple correlation experi- ients. Comparison is made with the predictions of the unified odel, but with very little success.

8577 EXCITED STATES ON N^{16} AND F^{16}.
T.W.Bonner, E.A.Davis, G.Din and H.M.Kuan.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 470-1.

Excited states in N^{16} at 1.29 and 1.71 MeV were observed in ie nuclear reaction $F^{19}(n,\alpha)N^{16}$. Corresponding levels in F^{16} at .88 and 1.26 MeV were observed in the reaction $N^{14}(He^3,n)F^{16}$. hese states are apparently in addition to the negative parity states alculated by Elliott and Flowers (Abstr. 717 of 1958).

8578 STUDY OF LOW LEVELS IN EVEN—EVEN NUCLEI OF THE 1d—2s SHELL. C.Broude and H.E.Gove.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 471-4.

Levels were excited by inelastic scattering of protons from a ndem accelerator. Angular correlations were measured on the mma cascades from these levels through the first excited state permit the assignment of spins. The energies of the levels udied, in MeV, are: Ne^{20} (4.25, 4.97), Mg^{24} (5.22, 6.01), Mg^{26} .97, 3.61, 3.97, 4.35), Si^{28} (4.62, 4.98, 6.28), Si^{30} (3.51, 3.79), ^{2} (3.78, 4.29, 4.47, 5.01).

8579 THE LEVELS OF Ne^{21} AND Ne^{23} AND THEIR INTERPRETATION. J.M.Freeman.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 477-80.

Excited states of Ne^{21} and Ne^{23} were determined accurately by udying (d,p) reactions in Ne^{20} and Ne^{22}. An interpretation of the lower Ne^{23} levels is suggested in terms of three rotational bands like those demonstrated in Al^{25} and Mg^{25}. The Ne^{21} scheme can be compared with Na^{23} and can be similarly analysed according to Nilsson's model [K.Danske, Vidensk. Selsk. mat.-fys. Medd., Vol. 29, No. 16 (1955)].

8580 REDUCED WIDTHS AND ISOTOPIC SPIN IMPURITY OF THE $\frac{1}{2}^+$ STATES OF N^{15}.
J.B.French, S.Iwao and E.Vogt.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 480-2.

The nuclear reactions C^{14} + p involve the interference of two adjacent $\frac{1}{2}^+$ levels of different isotopic spin ($T = \frac{1}{2}$ and $T = \frac{3}{2}$). A careful multilevel analysis of the cross-sections yields reduced width amplitudes and a direct estimate (4%) of the isotopic spin impurity of the levels—in moderate agreement with the results of intermediate-coupling shell-model calculations.

8581 SOME PROPERTIES OF Be^{11}.
S.Hinds, A.E.Litherland, R.Middleton and D.J.Pullen.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 486-8.

The levels of Be^{11} were studied by means of the $Be^9(t,p)Be^{11}$ reaction. The Q-value for the reaction was found to be − 1.164 ± 0.015 MeV. Excited states of Be^{11} at 0.319 ± 0.010 and 1.78 ± 0.02 MeV were found, the latter having a directly measured width of 110 ± 15 keV. Some new evidence for an even parity assignment to the ground state of Be^{11} is discussed.

8582 A DOUBLET AT 3.40 MeV EXCITATION IN Mg^{25}.
S.Hinds, A.E.Litherland and R.Middleton.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 489-91.

The well known 3.40 MeV level in Mg^{25} was studied by means of the $Mg^{24}(d,p)Mg^{25}$ and the $Al^{27}(d,\alpha)Mg^{25}$ reactions and shown to consist of two components at excitation energies of 3.398 ± 0.007 and 3.407 ± 0.007 MeV. The relative intensities of the components suggest that the upper member is the well known $\frac{9}{2}-$ state and the lower member probably is $\frac{9}{2}+$.

8583 ENERGY LEVELS OF N^{17}, O^{18}, AND O^{20}.
N.Jarmie and M.G.Silbert.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 491-4.

Study of the charged particles produced by triton bombardment of oxygen targets led to measurements of the mass of N^{17} (17.013 856 ± 0.000 017 a.m.u.) and O^{20}(20.010 430 ± 0.000 017 a.m.u.). The following previously unreported energy levels were observed: in O^{18}, 3.639 ± 0.015 and 4.457 ± 0.015 MeV; in O^{20} 1.682 ± 0.020, 4.091 ± 0.025 and 4.449 ± 0.025 MeV.

8584 THE FINE STRUCTURE OF THE PHOTO-PROTON ENERGY SPECTRUM AND THE NUCLEAR LEVELS OF Li^6. A.P.Komar.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 494-7.

The proton spectrum from $Li^5(\gamma,p)He^5$ and $Li^6(\gamma,n)Li^5 \rightarrow He^4 + p$ was measured up to Ep = 20 MeV for a bremsstrahlung spectrum with $E\gamma_{max}$ = 28 MeV. Peaks at 4.1, 4.5, 5.5 and 11.6 MeV are identified with levels in Li^6 at 9.5, 10.0, 11.2, and 18.3 MeV. E.J.Burge

8585 POSITIVE-PARITY STATES IN MASS-13 NUCLEI.
D.Kurath and R.D.Lawson.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 500-2.

The strength of coupling between the positive-parity nucleon and the C^{12} core is investigated. Strong coupling, as implied by using the Nilsson model to generate wave-functions, contradicts experiment. A reasonable picture arises from weak coupling with a strength consistent with that derivable from summing the two-body interaction integrals between the positive-parity nucleon and the core.

8586 NUCLEAR COUPLING SCHEMES WITH S-STATE INTERACTIONS. S.A.Moszkowski.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 502-5.

It may be that two-body interactions acting only in S-states of relative motion can give rise to observed features of nuclear coupling schemes. A purely attractive long-range S-state interaction gives

spectra similar to that resulting from contact interactions. An additional repulsion at short distances can lead to collective effects even without any interactions in $l \neq 0$ states.

8587 SOME PROPERTIES OF THE LOW-LYING LEVELS OF C^{11} OBTAINED FROM $B^{10}(d, n\gamma)C^{11}$.
G.C.Neilson, W.K.Dawson and J.T.Sample.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 505-8.

Information concerning the first four excited states of C^{11} was obtained through neutron angular distributions and n–γ correlations. The intensity of the group leaving C^{11} in the 1.99 MeV state is anomalously low; spin reversal may be involved. The other states show no unusual behaviour, except perhaps for the good agreement between stripping theory and the angular distribution of the group leaving C^{11} in the 6.50 MeV state.

8588 THE LOW LEVELS IN Si^{28} AND P^{29}.
K.Okano, T.Tabata and K.Fukuda.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 508-10.

The low levels in Si^{28} and P^{29} were studied by proton capture reactions on Al^{27} and Si^{28}. The decay schemes and spins were determined for some of the levels, including the second level in Si^{28}(4+) and the first (3/2+), second (5/2+) and fourth (5/2+) levels in P^{29}. The results obtained support the collective model interpretation (Abstr. 9810 of 1957) of excited states in these nuclei.

8589 THE SIGNIFICANCE OF THE GENERALIZED DENSITY OF STATES FUNCTION FOR NUCLEAR SPECTRA.
G.C.Phillips and L.C.Biedenharn.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 511-13.

8590 SINGLE PARTICLE LEVELS IN N^{16} FROM SCATTERING OF FAST NEUTRONS BY N^{15}.
C.P.Sikkema and R.van Wageningen.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 513-16.

Levels in N^{16} between 4.3 and 5.8 MeV excitation were studied by analysing data obtained in elastic n–N^{15} scattering. At about 5.0 MeV two broad single-particle levels were found, with $J^{\pi} = 1^-$ and 2^-. These are identified with the $(1p_{1/2})^{-1}1d_{3/2}$ ($J^{\pi} = 1^-$ and 2^-) states expected at about the same energy. In addition six narrower levels are reported.

8591 0^+ SECOND EXCITED STATE OF S^{32}.
T.Wakatsuki, Y.Hirao, E.Okada and I.Miura.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 521-4.

By the analysis of gamma rays from the reaction $S^{32}(p,p'\gamma)$, it was concluded that the spin and parity of the second excited state of S^{32} is 0^+. The cascade gamma rays from the second excited state were shown to be isotropic and gamma–gamma correlation to have the pattern $0^+(E2)2^+(E2)0^+$.

8592 NUCLEAR COUPLING SCHEMES AND THE MICROSCOPIC DESCRIPTION OF COLLECTIVE EFFECTS.
B.R.Mottelson.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 525-40, Disc., 540-6

8593 PARTICLE STATES IN STRONGLY DEFORMED NUCLEI. I.Perlman.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 547-62; Disc., 562.

8594 COULOMB EXCITATION OF VIBRATIONAL LEVELS. B.Elbek.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 563-6; Disc., 566-7.

Reviews recent experiments on heavy deformed nuclei.

8595 RADIATIVE PROPERTIES OF THE LOW LEVELS IN Cd^{114}. L.V.Groshev.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 568-72; Disc., 572.

The gamma rays in Cd^{114} produced by thermal neutrons on Cd^{113} were studied with a magnetic spectrometer with 0.3% resolution, and the internal conversion electrons were simultaneously investigated with 0.6% resolution. A new 0^+ level at 1305 keV was detected and interpreted as a collective level.
E.J.Burge

8596 ON THE NATURE OF THE FIRST 2+ LEVEL OF EVEN–EVEN SPHERICAL NUCLEI. S.T.Belyaev.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 587-9.

From the microscopic point of view, the 2+ state is shown to be a paired state of a particle in a hole, and the excitations are therefore an analogue of the "zero sound" of a finite Fermi system.
E.J.Burge

8597 MAGNETIC DIPOLE TRANSITION PROBABILITIES IN SOME ODD-A ROTATIONAL NUCLEI.
A.E.Blaugrund, Y.Dar and G.Goldring.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 590.

Measurements of lifetimes of first excited states in some odd-A rotational nuclei are reported. The B(M1) values for the transitions investigated are compared with B(M1) values for higher transitions in the same nuclei. The ratios of B(M1) values for the two transitions are compared with the predictions of the collective rotation theory.

8598 NUCLEAR STRUCTURE STUDIES IN THE TIN ISOTOPES WITH (d,p) AND (d,t) REACTIONS.
B.L.Cohen and R.E.Price.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 591-2.

The neutron single-particle states in the odd isotopes of tin were identified and their energies are listed; all but the $d_{5/2}$ are single nuclear levels.

8599 EFFECTS OF PAIR CORRELATION NEAR CLOSED SHELLS.
S.I.Drozdov, D.F.Zaretskii and A.B.Migdal.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 593-4.

Reports, without details, a system of equations analogous to those in the theory of superfluidity. Their solution yield the density matrix and the excitation spectrum of near-magic nuclei.
E.J.Burge

8600 STUDY OF SOME ISOMERIC STATES IN THE RARE EARTH REGION AND OF SOME DOUBLE ISOMERIC NUCLEI. P.F.Fettweis.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 606-9.

A close correlation is found between the double isomeric nuclei In^{114}, In^{116}, Ir^{192} and Ir^{194}. Isomeric states in Yb^{169}, Yb^{175} and Yb^{177} can be explained in terms of the Nilsson level-schemes. A close correlation with neighbouring odd-neutron nuclei is also found.

8601 EVIDENCE FOR A K = 0 ROTATIONAL BAND IN Ho^{166}.
J.S.Geiger, R.L.Graham and G.T.Ewan.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 610-12.

The properties of levels in Ho^{166} excited in the β-decay of 81 hr Dy^{166} were studied using a $\pi\sqrt{2}$ spectrometer. The transition intensities between levels at 0 keV 0-, 54.22 keV 2-, and 82.45 keV 1- indicate a common K = 0 assignment. These three levels form a K = 0 rotational band in which the odd spin member is displaced relative to the even spin members.

8602 ON THE VIBRATIONAL LEVELS OF NUCLEI.
B.T.Geilikman.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 612-14.

The mass coefficients of quadrupole vibrations are evaluated for an isotropic oscillator with additional terms due to the vibrations of the nuclear surface. The values of the mass coefficients are not significantly increased by the presence of energy levels close to one another within a shell.
E.J.Burge

8603 COMPARISON BETWEEN THE MODEL OF NUCLEAR QUADRUPOLE EXCITATIONS (VKV-MODEL) AND THE MODEL OF DAVYDOV AND FILLIPOV (NON-AXIAL ROTATOR) FOR NUCLEI WITH EQUI-DISTANT ENERGY SPECTRA.
D.P.Grechushina.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 614-16.

Experimental evidence claimed in support of the Davydov–Fillipov model is shown to give comparable support for the VKV model. Three critical tests are proposed: static quadrupole moments, isotopic and isomeric shifts of levels of the atomic electrons, and E0 transitions.
E.J.Burge

8604 CALCULATION OF CERTAIN PROPERTIES OF WEAKLY DEFORMED NUCLEI.
V.D.Konstantinov, A.M.Korolev, V.I.Ovcharenko and Yu.L.Gurin.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 625-9.

Nuclear surface oscillations associated with up to two phonons are allowed for in the Bohr unified model (Abstr. 4524 of 1952). The distance between collective levels is shown to be increased. Magnetic and quadrupole moments are calculated for 16 nuclei and are generally in better agreement with experiment than those given by shell model. The ft value for the β-decay $Sn^{121} \rightarrow Sb^{121}$ is also improved. E.J.Burge

8605 EVIDENCE FOR THE EXISTENCE OF ROTATIONAL LEVELS IN ALL EVEN–EVEN NUCLEI.
C.A.Mallmann.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 632-3.

A theory of rotations of even–even nuclei is developed which is more general than the one based on the hydrodynamical model. It is assumed that the rotational motion can be treated adiabatically and that the three effective moments of inertia and the two effective quadrupole moments are independent parameters. A small centrifugal distortion of the rotor is added as a correction term. The theoretical predictions for energy levels and gamma-ray transition probabilities are compared with experimental results for nuclei with $20 \leq A \leq 250$ and good agreement is obtained. The trends of the effective moments of inertia and effective quadrupole moments as a function of A are given.

8606 ON THE COLLECTIVE MOTION IN EVEN–EVEN SPHERICAL NUCLEI. T.Marumori.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 636-7.

A method formally analogous to that developed by Bogolyubov, Tolmachev and Shirkov (1958) to investigate the collective excitations in superconductors is applied to even–even spherical nuclei in order to investigate the mechanism of the nuclear collective motion from the standpoint of particle excitations.

8607 ROTATIONAL ENERGY LEVELS OF DEFORMED EVEN-EVEN NUCLEI. R.B.Moore and W.White.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 640-3.

A digital computer was used to extend calculations of rotational energy levels of deformed even-even nuclei treated in the manner of Davydov and Filippov (Abstr. 1722 of 1959). A comparison is made with the high spin states of Th^{232} and U^{238} recently realized by Coulomb excitation by heavy ions (Abstr. 448 of 1960).

8608 NUCLEAR LEVELS OF Sn^{118}.
M.K.Ramaswamy, W.L.Skeel, D.L.Hutchins and P.S.Jastram.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 643-6.

Directional polarization correlation measurements on gamma-rays following the decay of 5 hr Sb^{118} led to the following spin and parity assignments for levels (in MeV) in Sn^{118}: 1.22 (2^+), 2.25 (4^+) and 2.51 (5^-). The 2.55 MeV level is assigned 6^+ from log ft considerations. The most probable origins of the levels are as follows: 1.22 and 2.25 (quadrupole vibrational). 2.55 (particle excitations) and 2.51 ($\lambda = 5$, collective vibration).

8609 ENERGY LEVELS OF Fe^{57}.
J.F.Vervier and G.A.Bartholomew.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 650-2.

Angular correlation and circular polarization experiments were performed on the γ-rays following neutron capture in Fe^{56}. An analysis of the decay scheme of Fe^{57} is attempted on the basis of the Nilsson mode (Abstr. 3526 of 1957); similar considerations are applied to the ground-state magnetic and quadrupole moments of neighbouring odd proton nuclei.

8610 A NEW LEVEL SCHEME FOR Sr^{86}.
T.Yamazaki, H.Ikegami and M.Sakai.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 654-7.

The level scheme for Sr^{86} was investigated from the decay of ^{86}. Many new complex gamma rays and five positron components were observed with a beta-ray spectrometer, and a coincidence study was performed. In addition to the 1.08 MeV first excited state, a new 2.25 MeV second excited state, of spin 4, and other higher excited states were found.

8611 STRENGTH FUNCTIONS AND GROSS STRUCTURE. J.P.Schiffer.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 676-92; Disc., 693-6.

8612 SPACING DISTRIBUTION AND LEVEL-DENSITY IN RANDOM MATRIX APPROXIMATION. M.L.Mehta.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 776-9.

The distribution function of the level-spacings of a random matrix are strictly majorized and minorized, showing that Wigner's theory is a good approximation. However, an exact calculation of the first derivatives of the distribution function at zero spacing shows that it is not rigorously exact. The exact level-density is derived in collaboration with M.Gaudin.

8613 CORRELATIONS IN NUCLEON MOTIONS. H.W.Newson.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 780-3.

After correcting for the dependence on excitation and angular momentum (J) of the compound nucleus, it is found that the s-wave resonance spacing decreases according to the relation $\exp(-0.45\ T)$ where T is the neutron excess. This effect is interpreted as a sign of the correlations in nucleon motion which are to be expected from the nature of exchange forces.

8614 VIBRATIONS IN SPHERICAL AND NEARLY SPHERICAL NUCLEI. P.H.Stelson.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 787-800.

Review. Includes graphical summaries of the observed quadrupole distortions for most even–even nuclei, the ratio of the energies of second to first excited states as a function of the energy of the first excited state for even–even nuclei, and compares the ratios $B(E2, 2' \rightarrow 2)/B(E2, 2 \rightarrow 0)$ and $B(E2, 2' \rightarrow 0)/B(E2, 2 \rightarrow 0)$ with the predictions of the Davydov–Filippov model (Abstr. 1722 of 1959) for the rotational states. E.J.Burge

8615 ROTATION–VIBRATION INTERACTION IN NON-AXIAL EVEN ATOMIC NUCLEI. A.Davydov.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 801-7; Disc., 807-13.

8616 CORE EXCITATIONS IN NONDEFORMED, ODD-A NUCLEI. A.de-Shalit.
Phys. Rev. (USA), Vol. 122, No. 5, 1530-6 (June 1, 1961).

The possibility of describing some-excited states of odd-A nuclei in terms of excitations of the even–even core is investigated. No assumption is made on the nature of the core excitation, but certain relations involving electromagnetic transitions and moments are deduced. These seem to fit well some data available on Ag^{107}, Ag^{109}, Au^{197}, Hg^{199}, Tl^{203}, and Tl^{205}. More experimental data are required to test the validity of this picture in other cases.

8617 THE ISOBARIC TRIPLETS IN THE NUCLEAR 2p-SHELL AND THE CHARGE INDEPENDENCE OF NUCLEAR FORCES. W.M.Fairbairn.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 599-609 (March, 1961).

The positions of the lowest lying T = 1 levels in the 2p-shell nuclei with $T_3 = 0$ are calculated from the experimental positions of the ground states of the nuclei with $T_3 = +1$ and the energy differences between the ground states of the nuclei with $T = \frac{1}{2}$. Coulomb forces are considered as a perturbation in the shell model and it is shown that, apart from small terms which depend on symmetry, the method is equivalent to that used by Wilkinson (1956). The corrections due to symmetry are of the same order of magnitude as the significant differences which Wilkinson found between the experimental and the calculated positions of the $T = 1$, $T_3 = 0$ levels, and when these corrections are included the differences are no longer significant. The energy shift due to the charge dependence of nuclear forces caused by the pion mass difference is calculated and is shown to be appreciable. There is good agreement between theory and experiment for the isobars with A = 14.

Al^{26} AND Mg^{26} LEVELS. See Abstr. 7377

8618 GAMMA RADIATION FROM LOW LEVELS OF Al^{27}. R.D.Bent and W.W.Eidson.
Phys. Rev. (USA), Vol. 122, No. 5, 1514-17 (June 1, 1961).

The $Al^{27}(\alpha, \alpha\gamma)$ reaction was investigated by using particle–gamma coincidence techniques and the 22 MeV alpha-particle beam from a cyclotron. A 0.79 ± 0.03 MeV gamma-ray transition between the 3.0 and 2.21 MeV states of Al^{27} was observed. This result, together with other data, suggests that the 3.0 and 2.21 MeV states are the $\frac{9}{2}^+$ and $\frac{7}{2}^+$ members of a $K = \frac{5}{2}$ rotational band.

LEVELS IN Be^8, FROM $Li^7(p,\gamma)Be^{8*}(\alpha)He^4$. See Abstr. 8719

8619 NONEXISTENCE OF A 9.0 MeV LEVEL IN C^{12}. D.E.Alburger and D.H.Wilkinson.
Phys. Rev. (USA), Vol. 122, No. 5, 1508-9 (June 1, 1961).

An energy level in C^{12} at 9.0 MeV has been reported (Abstr. 17558 of 1960) as a result of (p,γ,γ) triple coincidence measurements on the $B^{10}(He^3,p)C^{12}$ reaction at $E(He^3) = 2.2$ MeV. This reaction was reinvestigated in a similar experimental arrangement by using alternately Pilot-B, CsI and NaI scintillators for detection of the protons. Only the Pilot-B, which had been used in the previous work, exhibits the proton group corresponding to a "9.0 MeV level" in C^{12}. The triple coincidence effect in this case is actually due to the intense ~ 17 MeV protons in the $B^{10}(He^3,p)C^{12}$ reaction leading to the 4.43 MeV first excited state of C^{12}, which upon entering the scintillator can inelastically scatter from carbon and produce secondary gamma radiation of 4.43 MeV. The net energy deposited in the scintillator has the appearance of a proton group to a 9.0 MeV level in C^{12} in triple coincidence with two 4.43 MeV gamma rays. The magnitude of the effect is calculated from published cross-sections for inelastic scattering and it agrees with the apparent population intensity of the nonexistent "9.0 MeV level".

Ca^{40} EXCITED LEVELS. See Abstr. 7402

8620 ON THE FIRST AND THE SECOND EXCITED STATES IN Ge^{74}. T.Yamazaki, H.Ikegami and M.Sakai.
J. Phys. Soc. Japan, Vol. 15, No. 6, 957-64 (June, 1960).

The states were studied from the decay of As^{74}. The possibility of the presence of an 0+ excited level was checked by searching for an internal conversion line corresponding to an E0 transition by means of a beta-ray spectrometer, but no detectable peak was observed. From the gamma–gamma coincidence measurements, the relative intensity $T(2' \rightarrow 2)/T(2' \rightarrow 0)$ was found to be 1.7. From the gamma–gamma angular-correlation measurements the spin of the second excited state was assigned to be 2 and the E2/M1 mixing ratio δ in the $2' \rightarrow 2$ gamma transition was found to be $-(1^{+9}_{-0.5})$. These results are discussed in view of systematics on the medium-weight even–even nuclei.

8621 INTRINSIC EXCITED STATES IN Hf^{178} POPULATED BY THE ALLOWED DECAY OF 9.3 MIN Ta^{178}. C.J.Gallagher, Jr, H.L.Nielsen and O.B.Nielsen.
Phys. Rev. (USA), Vol. 122, No. 5, 1590-9 (June 1, 1961).

The levels in Hf^{178} populated by the allowed positron and electron capture decay of 9.3 min Ta^{178} were investigated with a six-gap spectrometer. Conversion-electron spectrum and beta–gamma coincidence measurements established the spin and parities of levels in Hf^{178} with energies (in keV) 93(2+), 307(4+), 1197(0+), 1277((2+)), 1430((1+)), 1440(0+), and 1483(2+), and possibly a level at 1550. (Double parentheses indicate that the spin is not definitely established). Intrinsic configuration assignments for the excited states are discussed in terms of recent theoretical developments. The half-life of the 93 keV level was measured and found to be $(1.25 \pm 0.08) \times 10^{-9}$ sec. The β^+/K capture ratio measured for the allowed decay to ground is within experimental error of theory. Reduced E0/E2 transition probability ratios for the transitions depopulating the 1197 and 1440 keV 0+ levels are calculated from the observed K-conversion line intensities of the E0 and E2 transitions depopulating the levels.

8622 LEVELS IN Ho^{162} AND Dy^{162}. M.Jørgensen, O.B.Nielsen and O.Skilbreid.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 443-55 (May, 1961).

An activity with half-life 11.8 min, representing the ground state of Ho^{162}, was isolated by a recoil method from the 68 min Ho^{162} activity which belongs to an isomeric level about 90 keV above the ground state. A decay scheme for the Ho^{162} levels is proposed, indicating the following levels in Ho^{162}: ground state, $(K, I^\pi) = (1, 1^+)$; 38.5 keV $(1, 2^+)$; 86.5 keV $(1, 3^+)$; ~ 90 keV $(6, 6^-)$. In Dy^{162} the following levels are proposed: 81 keV $(0, 2^+)$; 266 keV $(0, 4^+)$; 549 keV $(0, 6^+)$; 1485 keV $(5, 5^-)$. Single-particle assignments in the Nilsson–Mottelson scheme can be proposed for the unpaired particles of the ground state and the 90 keV states of Ho^{162} as well as of the 1485 keV level of Dy^{162}, based on the above spins and the fact that the K-capture transitions from Ho^{162} are allowed unhindere

8623 A DOUBLET AT 3.40 MeV EXCITATION IN Mg^{25}. S.Hinds, R.Middleton and A.E.Litherland.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 510-13 (May, 1961).

The well known 3.40 MeV level in Mg^{25} was studied by means of the $Al^{27}(d, \alpha)Mg^{25}$ and the $Mg^{24}(d, p)Mg^{25}$ reactions. In both reactions the level was resolved into two components, separated by 9 ± 2 keV, at 3.407 ± 0.007 and 3.398 ± 0.007 MeV. In the (d, p) reaction the level at the lower excitation energy was weakly excited indicating that the upper member is the well know $\frac{3}{2}^-$ state. In the (d, α) reaction the reverse was observed, the lower level being consistently the stronger. The relative intensities of the members of the doublet in the (d, α) reaction suggest that the new level in Mg^{25}, at 3.398 ± 0.007 MeV, has spin $\frac{9}{2}$ and consequently corresponds to the 3.44 MeV $(\frac{9}{2}^+)$ level in the mirror nucleus Al^{25}.

8624 REDUCED WIDTHS AND ISOTOPIC SPIN IMPURITIES OF $\frac{1}{2}^+$ STATES OF N^{15}. J.B.French, S.Iwao and E.Vogt.
Phys. Rev. (USA), Vol. 122, No. 4, 1248-59 (May 15, 1961).

The nuclear reactions $C^{14}(p,n)N^{14}$ and $C^{14}(p,\gamma_0)N^{15}$ for protons of less than 1.6 MeV involve the interference of two adjacent states having the same spin and parity $(\frac{1}{2})$ but different isotopic spin $(T = \frac{1}{2}$ and $\frac{3}{2})$. By taking properly into account the effect of other, more distant $\frac{1}{2}^+$ levels on the cross-section near the interfering pair of levels, the authors are able to fit well the (p,n) cross-secti from the neutron threshold up to a proton energy of 1.6 MeV and to obtain reliable estimates for the reduced width amplitudes of the interfering pair, as well as for the physically significant phases of the amplitudes. Since the neutron decay of the $T = \frac{3}{2}$ state is "forbidden", the neutron reduced widths of the close-lying pair le to a direct measure of the isotopic spin impurity of the pair. The results found in the cross-section analysis are compared to shell model calculations based on the N^{15} wave-functions of Halber and French, and reasonably satisfactory agreement is found.

8625 LEVELS IN ^{16}N FROM SCATTERING OF FAST NEUTRONS BY ^{15}N. C.P.Sikkema.
Physica (Netherlands), Vol. 26, No. 6, 379-80 (June, 1960).

The elastic scattering of fast neutrons by N^{15} was studied in t energy range 1.9 to 3.5 MeV using a proportional counter filled wi nitrogen enriched in N^{15}. The total cross-section for N^{15} is obtain and shows several unresolved resonances. The cross-section cur is analysed in terms of suggested properties of these resonances.
L.L.Gre

LOW-LYING ENERGY STATES IN Ne^{20}. See Abstr. 7398

Si^{28} LEVELS. See Abstr. 7372

8626 NUCLEAR ENERGY LEVELS OF Na^{24} IN THE REGION FROM 350 TO 630 keV. C.T.Hibdon.
Phys. Rev. (USA), Vol. 122, No. 4, 1235-48 (May 15, 1961).

For previous work on levels at 1-350 keV, see Abstr. 9534 of 1960. The neutron cross-section data from 350 to 630 keV show 71 peaks, consisting of a relatively small number of large peaks and many small peaks. Each of the previously known large peaks was resolved into two or more components. The analyses show a few s-wave levels, a small number of p-wave levels, and a large number of d- and f-wave levels. For all of the levels of Na^{24} up to 630 keV, a plot of the number of levels having energies $\leq E_n$ as a function of the neutron energy E_n shows an essentially linear distribution. The distribution of the angular momenta is in agreement with the theoretical distribution for a value of $\sigma = 1.8$. The level spacings appear to agree with an exponential distribution. For the reduced neutron widths, the results appear to agree equall well with the exponential and Porter–Thomas distributions. The strength function obtained from the reduced widths has an average value of 0.045 for both values of J for $l = 0$ and an average value o 0.37 for all values of J for $l = 1$. For higher values of l, the stren function is too large. An expression developed for the distribution of the levels above the ground state tends to agree with the data fo a value of 0.50 MeV for δ, the average level spacing of the nucleon in the nucleus.

8627 NUCLEAR SPECTROSCOPY OF Ta^{181}.
A.H.Muir, Jr and F.Boehm.
hys. Rev. (USA), Vol. 122, No. 5, 1564-73 (June 1, 1961).

The nuclear levels of Ta^{181} were investigated by a study of the -decay of Hf^{181} and the electron capture decay of W^{181}. Evidence for eak M-shell conversion lines of an ~6 keV transition in Hf^{181} was und with a β-spectrometer. An investigation of the W^{181} decay with is instrument revealed strong M shell conversion lines corres- onding to a 6.25 ± 0.3 keV transition. With the aid of additional idence, it is concluded that the 476 keV transition in the Hf^{181} ecay occurs between the 482 keV level and a new level at 6 keV. n using an argon proportional counter, a 6 keV γ-ray was also und in the W^{181} decay. The conversion coefficient of this transition as determined to be $\alpha_T = 44 \pm 7$. This conversion coefficient and e M-subshell conversion ratios indicate that the 6 keV transition of E1 multipolarity. The 6 keV level is assigned as the [514] Nilsson intrinsic state. It is also concluded that the pre- ously reported 152 keV transition in the W^{181} decay occurs be- een a new $\frac{11}{2}^- (K = \frac{9}{2}^-)$ rotational level at 158 keV and the 6 keV vel. From a measurement of the tantalum L/K X-ray intensity tio, the W^{181} decay energy is found to be 176^{+44}_{-22} keV. The anchings of this decay to the various Ta^{181} levels are as follows: 8 keV (0.11%), 136 keV (0.067%), 6.25 keV (~35%), and ground ate (~65%). All findings and proposals are consistent with pre- ctions of the unified model of the nucleus.

NUCLEAR DECAY RADIOACTIVITY

8628 THE TRANSURANIUM ELEMENTS.
G.T.Seaborg.
ithsonian Rep. (USA), 1959, 247-62.

The present situation in the production of transuranic elements to Z = 102 by neutron or charged-particle irradiations is viewed, and the techniques used in the production and identifica- on of each element are described. Several of these have been und in the debris of thermonuclear explosions. In the identifica- on of transuranic elements, ion exchange techniques, together with emical comparison of the actinide elements with the correspond- g lanthanide elements with similar electronic structures, have en of great importance. Possibilities of extending the production transuranics beyond Z = 102 are discussed. Predictions of half- es and chemical properties are made. R.E.Meads

8629 APPARATUS FOR THE DETECTION OF CARBON 14 AND TRITIUM. R.Bibron. G.Delibrias and C.Léger.
uclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 2720 of 1960) p. 157-61. In French.

For these low-energy activities it is necessary for the dectector be immersed in the radioactive material. A proportional gas ounter and two liquid scintillators are briefly described. W.G.Stripp

ESTIMATION OF URANIUM AND THORIUM IN RADIO- CTIVE ORES BY γ-SPECTROMETRY. See Abstr. 7926

8630 THE DECAY OF Br^{78}.
R.Rikmenspoel and D.M.van Patter.
uclear Phys. (Internat.), Vol. 24, No. 3, 494-9 (May, 1961).

Br^{78} sources were produced by proton bombardment of iso- pically enriched (97%) thin targets of Se^{78} in order to investigate e decay scheme of Br^{78}. The $Se^{78}(p, n)Br^{78}$ threshold was easured at 4.40 ± 0.01 MeV, using a slow-fast neutron counter rrangement. Annihilation radiation with a half-life of 6.5 ± 0.1 min as observed for bombardments with $E_p \geq 4.40$ MeV. Using an thracene crystal, the end-point of the β^+ spectrum of Br^{78} was easured, and was found to be consistent with the value of 2.54 ± 0.01 MeV calculated from the $Se^{78}(p, n)$ threshold determination. easurements of the γ-ray spectrum of Br^{78} indicate a γ-ray of 613 ± 0.003 MeV, of intensity 0.14 ± 0.015 that of all positrons, hich is assigned to the known first 2+ state of Se^{78}. Excitation of e known second 2+ state at 1.31 MeV was not observed, occurring th ≤0.4% of the decays, with log ft ≥ 5.9. The results indicate at the ground state of Br^{78} has spin and parity of 1+.

8631 TRIPLE ISOMERISM IN Ir^{194}.
K.F.Alexander and H.F.Brinckmann.
Z Naturforsch. (Germany), Vol. 16a, No. 2, 210 (Feb., 1961). In German.

The half-life of the short-lived isomer of Ir^{194} is determined to be 32 ± 2 msec and a tentative decay scheme is suggested. S.J.St-Lorant

8632 THE 5.3 SEC ISOMER OF W^{183}.
C.J.Gallagher, Jr, and H.K.Nielsen.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 422-30 (May, 1961).

A 5.3 sec isomer of W^{183} was chemically separated from its parent 5.2 d Ta^{183}. The radiations from the isomer were observed with a xenon proportional counter and a NaI scintillation crystal and have energies of 46, 52,~ 105 and ~ 160 keV. Gamma–gamma coincidence measurements involving the photons were made. On the basis of these results and previously reported high resolution measurements of the decays of Ta^{183} and Re^{183}, the energy of the isomeric level is assigned as 309.49 keV, and its spin and parity as $\frac{9}{2}+$.

8633 THE NUCLEAR ALINEMENT OF PROMETHIUM ISOTOPES AND THE DECAY SCHEME OF ^{149}Pm.
C.J.S.Chapman, M.A.Grace, J.M.Gregory and C.V.Sowter.
Proc. Roy. Soc. A (GB), Vol. 259, 377-85 (Dec. 29, 1960).

Nuclear alignment of the isotopes Pm^{149} and Pm^{151} was obtained in the ethyl sulphate and double nitrate lattices by the low-temperature alignment method The anisotropic γ-ray angular distributions were used to detect this alignment. The results suggest that in the double-nitrate lattice the lowest ionic state of Pm^{3+} is a singlet and that alignment arises through a "pseudo-quadrupole" mechanism. Beta and γ-spectroscopy measurements show that the 285 keV γ-ray in the decay of Pm^{149} is associated with a weak (1.8 ± 0.3%) β-group of maximum energy 0.77 ± 0.05 MeV. The alignment measurements are consistent with this 285 keV γ-ray being principally M1 with the spin of the excited state being 5/2 or 9/2.

NEW ISOTOPE OF MANGANESE. See Abstr. 7396

8634 A SEARCH FOR PARITY-FORBIDDEN ALPHA-DECAY FROM THE 8.88 MeV (2^-) STATE IN O^{16}.
W Kaufmann and H.Wäffler.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 62-8 (April, 1961).

The parity-forbidden alpha-decay of the O^{16} 8.88 MeV (2^-) state into $C^{12} + \alpha$ has been proved to be less frequent that the alpha-decay of the 9.58 (1^-) state by a factor $< 1.4 \times 10^{-6}$. From this experimental fact, an upper limit for the intensity F^2 of a possible opposite parity admixture to the 8.88 MeV state in O^{16} can be derived. It depends on the assumption made about Γ_α, the level width of a hypothetical 8.88 MeV (2^+) state in O^{16} and ranges between $F^2 \leq 1.3 \times 10^{-12}$ to 1.3×10^{-11} according to Γ_α = 6 keV to 0.6 keV.

8635 POSSIBLE PARITY AND TIME-REVERSAL EXPERIMENTS USING THE MÖSSBAUER EFFECT.
M.Morita.
Phys. Rev. (USA), Vol. 122, No. 5, 1525-6 (June 1, 1961).

In the successive transition of the beta and gamma decays, the excited and ground states of the daughter nucleus are effectively polarized when the satellites of the Mössbauer effect are separately observed. Using this nuclear polarization, various experiments are proposed to detect parity nonconservation and time-reversal invariance in beta decay. These experiments involve the measurement of the coincidence counting rate of beta rays and satellites of the Mössbauer effect. The resulting improvement in accuracy will make possible, for example, the precision measurement of the asymmetry of beta-ray angular distributions.

8636 COUPLING CONSTANT DETERMINATIONS FROM INVESTIGATIONS OF NUCLEAR BETA-DECAY.
O.Kofoed-Hansen.
"Weak Interactions", Varenna Summer school, 1959 (see Abstr. 7195 of 1961) p. 251-79.

Selected experiments that help to determine the form and strength of the β-decay coupling are reviewed. Diagrams of apparatus are shown. R.J.N.Phillips

8637 ON THE DECAY SCHEME OF ^{128}Cs.
S.Jha, R.K.Gupta, H.G.Devare, G.C.Pramila and K.P.Gopinathan.
Nuovo Cimento (Italy), Vol. 20, No. 1, 76-86 (April 1, 1961).

The results of the β-ray spectrometer and scintillation spectrometer studies of the 2.5 min Cs^{128} decay are presented. The Fermi-

plot of the positron spectrum taken in Siegbahn–Slätis spectrometer gives the following end-point energies: (2885 ± 25) keV (100, log ft 4.8), (2445 ± 25) keV (39, log ft 5.1), (1900 ± 40) keV (≤ 16, log ft ≥ 5.1) and (1300 ± 40) keV (≤ 8, log ft ≥ 4.6). The analysis of the γ-ray spectra in scintillation spectrometers shows the following γ-rays: 168 keV (10), 270 keV (23), 440 keV (50), 511 keV (200), 970 keV (1.5), 1120 keV (2.1), 1660 keV (0.4), 2180 keV (0.36), 2420 keV (0.2). With the help of these data, $\beta^+-\gamma$ and $\gamma-\gamma$ coincidence studies, the following levels in Xe^{128} are suggested: Ground state (0^+), 440 keV (2^+), 970 keV (2^+), 1560 keV (0^+ or 2^+) (all fed by positrons and electron captures), 2620 keV (perhaps 3^-) and 2860 keV (2^+) fed by electron captures only. It is suspected that the 2620 keV state may be the first octupole vibrational level.

8638 BETA DECAY OF NATURALLY RADIOACTIVE In^{115}.
G.B.Beard and W.H.Kelly.
Phys. Rev. (USA), Vol. 122, No. 5, 1576-9 (June 1, 1961).

A liquid scintillator loaded with indium was used to study the fourth-forbidden beta decay of In^{115}. Specific activity measurements yield a half-life of $(6.9 \pm 1.5) \times 10^{14}$ years. A crude beta spectrum was obtained. Linear extrapolation of the Fermi–Kurie plot gives an end-point energy of 625 ± 70 keV.

8639 DECAY OF Er^{172} AND Tm^{172}.
C.J.Orth and B.J.Dropesky.
Phys. Rev. (USA), Vol. 122, No. 4, 1295-301 (May 15, 1961).

Er^{172} was produced by double neutron capture in enriched Er^{170}. The beta decay of 50.4 hr Er^{172} and its daughter, 63.7 hr Tm^{172}, was studied with a solenoidal beta spectrometer and beta and gamma scintillation spectrometers. The highest energy group of the Tm^{172} beta spectrum has an end-point energy of 1.83 MeV; this group represents the $Tm^{172} \rightarrow Yb^{172}$ ground-state beta transition. The beta decay of Tm^{172} is accompanied by gamma rays of the following energies: 0.079, 0.180, 0.422, 0.495, 0.915, 1.095, 1.29, 1.39, 1.41, 1.47, 1.51, and 1.59 MeV. A decay scheme for Tm^{172} is proposed with excited states in Yb^{172} at 0.079, 0.259, 1.174, 1.47, 1.55, 1.59, and 1.67 MeV. The beta decay of Er^{172} is accompanied by gamma rays of the following energies: 0.050 (Tm K X-ray), 0.108, 0.126, 0.408, and 0.610 MeV, the last of which represents a transition to the Tm^{172} ground state. The beta spectrum measured in coincidence with the 0.610 MeV gamma-ray has an end-point energy of ~0.26 MeV, which establishes a decay energy of 0.87 MeV for Er^{172}.

8640 DECAY OF I^{134}.
N.R.Johnson, E.Eichler, G.D.O'Kelley, J.W.Chase and J.T.Wasson.
Phys. Rev. (USA), Vol. 122, No. 5, 1546-58 (June 1, 1961).

The decay properties of 53 min I^{134} were investigated with scintillation techniques as part of a programme for the systematic study of xenon energy levels. Energies (and intensities) of the gamma rays determined from the single-crystal and coincidence studies are 0.135 (3.2), 0.18, 0.23, 0.27, 0.32, 0.39 (7.2), 0.41 (0.6), 0.43 (2.9), 0.51 (0.9), 0.54 (8.4), 0.61 (19), 0.69 (7.3), 0.75 (1.3), 0.77 (6.0), 0.848 (100), 0.864 (4.6), 0.890 (74), 0.96 (2.0), 1.00 (4.7), 1.07 (18), 1.15 (10), 1.28 (1.4), 1.34 (1.5), 1.46 (3.7), 1.49 (1.0), 1.62 (4.9), and 1.79 (4.9) MeV. There are two gamma rays at each energy of 0.89 and 1.07 MeV. The single-crystal spectra were corrected experimentally for gamma-ray summing. Gamma coincidence spectra were measured by gating at energies of 0.135, 0.41, 0.61, 0.85, 0.89, 1.00, 1.07, 1.15, 1.46, 1.62, and 1.79 MeV in the gamma-ray spectrum. Beta-ray spectra were measured in coincidence with gamma rays at 0.85, 1.00, 1.07, 1.15, 1.46, 1.62, and 1.79 MeV. These measurements and the single-crystal data disclosed beta rays with end-point energies of 2.41, 2.21, 1.68, 1.49, 1.25, and 1.05 MeV. In a three-crystal "$\beta-\gamma-\gamma$" experiment the 2.41 MeV beta-ray group was shown to populate a level in Xe^{134} at 1.74 MeV; therefore, the energy difference between the ground states of I^{134} and Xe^{134} is 4.15 ± 0.06 MeV. A decay scheme is proposed with energy levels (and spins) in Xe^{134} at 0.85 (2+), 1.62 (2+), 1.74 (4+), 1.92, 2.34, 2.43, 2.48, 2.64, 2.88, 3.11, 3.30, and 3.41 MeV. A collective nature of the low-lying levels is suggested in that the 1.62 and 1.74 MeV states appear to be members of a "vibrational" doublet at about twice the energy of the first excited state. The half-life of I^{134} was redetermined as 52.8 ± 0.3 min.

8641 EXPERIMENTAL STUDY OF THE SPECTRUM OF AUTOIONIZATION ELECTRONS IN RADIOACTIVE β-DECAY. F.Suzor.
J. Phys. Radium (France), Vol. 21, No. 4, 223-8 (April, 1960). In French.

Following experiments already published on P^{32}, S^{35}, Pm^{147}, results are given for Y^{90}, Pr^{143}, and Na^{22}. The intensities of the X, K or L lines, are in good agreement with the theory of autoionization. On the other hand the continuous spectra, between 1 a 13 keV, of autoionization electrons emitted simultaneously with β radiation disagree with theoretical predictions. (The intensity is greater, the spectral distribution is different, and the law of variation versus Z is inverted). This could be explained by a contribution from external electronic shells considerably more important than that predicted by the autoionization theory.

8642 SCINTILLATION SPECTROMETRY STUDY OF THE ^{73}Se ISOMERIC PAIR.
R.A.Ricci, R. van Lieshout and H.J. van den Bold.
Physica (Netherlands), Vol. 26, No. 11, 14-20 (Nov., 1960).

The positron and the gamma-ray spectra of the two Se^{73} isomers were studied with a scintillation spectrometer. No new gamma-rays have been observed in the decay of the (7.1 ± 0.2) ho activity. The (42 ± 3) min activity shows a positron group of (1.72 ± 0.10) MeV and three gamma rays of 88, 251 and 580 keV a possibly one of 1080 keV. The relative position of the two isomer cannot be deduced from the results of these measurements; no isomeric transition has been identified with certainty. If an iso- meric transition occurs, it might be associated with the gamma r of 88 keV which then should be of M3 or E3 character, but this interpretation is not very attractive in view of shell model predictions for Se^{73}.

8643 BETA EMISSION FROM ORIENTED ^{160}Tb AND ^{166m}Ho NUCLEI.
H.Postma, M.C.Eversdijk Smulders and W.J.Huiskamp.
Physica (Netherlands), Vol. 27, No. 2, 245-59 (Feb., 1961).

An asymmetry of about $-(v/c)f_1$ of the β-emission from polan ized Tb^{160} nuclei was found. In the case of polarized Ho^{166m} nuclei an asymmetry of about −8% was detected. No anisotropy of the β emissions from aligned Tb^{160} and Ho^{166m} nuclei was found. It is c cluded that the groundstate of Tb^{160} has spin and parity 3−. In the case of Ho^{166m} several possibilities of spin and parity are rejecte on the basis of the experimental results. Spin and parity of Ho^{166} are probably 6−. Some considerations on the basis of the unified model are given.

8644 DECAY OF Zn^{63}.
J.B.Cumming and N.T.Porile.
Phys. Rev. (USA), Vol. 122, No. 4, 1267-74 (May 15, 1961).

The decay of 38.4 min Zn^{63} was investigated using scintillati and beta spectrometer techniques. 84% of the decays are to the Cu^{63} ground state. Gamma rays having energies of 0.67, 0.96 and 1.42 MeV are present with intensities of 9.0, 6.7, and 0.9% of the β^+ transitions. Low-intensity gamma rays (<0.2%) were observe at energies of 1.55, 1.83, 2.04, 2.34, 2.55, 2.77, and 3.10 MeV. Coincidence measurements established positron feeding of the Cu levels at 0.67, 0.96 and 1.42 MeV but no $\gamma-\gamma$ coincidences were o served. Internal conversion coefficients of the 0.67 and 0.96 MeV gamma rays are in agreement with predominantly M1 assignment to both transitions. A decay scheme is presented which differs significantly from that previously reported. It is inferred that th spin of Zn^{63} is $\frac{3}{2}^-$. M1 and E2 transition probabilities between th various levels of Cu^{63} and Cu^{65} are discussed in terms of the "centre-of-gravity" model for states in these nuclei. Both agree ments and disagreements with the model predictions are observe

8645 NEUTRON-DEFICIENT NUCLIDES OF HAFNIUM AN LUTETIUM. E.R.Merz and A.A.Caretto, Jr.
Phys. Rev. (USA), Vol. 122, No. 5, 1558-63 (June 1, 1961).

New neutron-deficient nuclides of lutetium and hafnium were produced by bombarding lutetium oxide with 300 to 400 MeV prot The genetic relationships and mass assignments were establishe by means of high-purity chemical separations and a series of chemical isolation experiments in which the daughter activity wa determined as a function of time. The positron spectra of the different nuclides were measured with an anthracene crystal de- tector and a 256 channel pulse height analyser. Gamma radiatio also observed for Lu^{168}, Lu^{169}, Lu^{170}, Hf^{168}, and Hf^{169} by means of NaI crystal detector and the pulse height analyser. The half-live and maximum positron energies observed are: Lu^{168}, $T_{1/2}$ = 7.0 E_{β^+} = (1.20 ± 0.05) MeV; Lu^{169}, $T_{1/2}$ = 1.5 days; Lu^{170}, $T_{1/2}$ = 1.9 d E_{β^+} = (1.8 ± 0.1) MeV; Hf^{168}, $T_{1/2}$ = 22 min, E_{β^+} = (1.7 ± 0.1) Me Hf^{169}, $T_{1/2}$ = 1.5 hr; Hf^{170}, $T_{1/2}$ = 9 hr.

8646 ORIENTED NUCLEI.
L.Rosenfeld.
'eak Interactions", Varenna Summer School, 1959 (see Abstr. 95 of 1961) p. 197-250.
Develops the theory of angular correlations for processes volving oriented nuclei. Discusses some applications to allowed transitions, three-particle emission and $\beta-\gamma$ correlations.
R.J.N.Phillips

8647 ANGULAR DEPENDENCE OF THE $\beta-\gamma$ CORRELATION (CIRCULARLY POLARIZED) IN Au^{198}.
.Deutsch and P.Lipnik.
clear Phys. (Internat.), Vol. 24, No. 1, 138-42 (April, 1961).
French.
Angular dependence of the beta–gamma circular polarization rrelation in Au^{198} was measured. It can be described by a cosine ction, which is the prediction of the so-called "ξ-approximation". imit s a possible P_3 term in the distribution function is set by ratio $A_3/A_1 = -0.13 \pm 0.25$.

8648 TRANSITIONS BETWEEN LOW-LYING EXCITED STATES OF Mn^{56} AND Ho^{166}.
.Estulin, A.S.Melioransky and L.F.Kalinkin.
clear Phys. (Internat.), Vol. 24, No. 1, 118-25 (April, 1961).
The measurement of coincidences of cascade-quanta is used as echnique for investigating the low-lying levels of odd nuclei of ^{56} and Ho^{166} arising in the radiative capture of thermal neutrons. duced probabilities of M1 and E2 mixed radiative transitions with ergies of 25 and 85 keV are found for Mn^{56}. The rotational band 2^- (54.2 keV) and 4^- (174 keV) is detected in the strongly de- rmed nucleus Ho^{166}.

8649 GAMMA–GAMMA DIRECTIONAL CORRELATIONS IN Nd^{147}. A.P.Arya.
ys. Rev. (USA), Vol. 122, No. 4, 1226-31 (May 15, 1961).
Directional correlation measurements were made on the 320 to keV and 280 to 320 keV gamma-ray cascades in Pm^{147}, following e decay of 11.1-day Nd^{147}, with a coincidence scintillation spectro- eter using NaI detectors. The observed correlation functions are: $(\theta) = 1 - (0.1030 \pm 0.0298)P_2(\cos\theta) + (0.0107 \pm 0.0099)P_4(\cos\theta)$, d $W(\theta) = 1 + (0.0710 \pm 0.0162)P_2(\cos\theta) - (0.0126 \pm 0.0103)P_4$ os θ), respectively, for the two cascades. The energy levels of ^{147} at ground state, 92, 410, and 690 keV were found to be $\frac{7+}{2}$, $\frac{7+}{2}$, and $\frac{5+}{2}$, respectively. It was found that the 92 keV gamma- y has a mixture of (95 ± 2)% M1 and (5 ± 2)% E2 with = + (0.229 ± 0.143); the 320 keV gamma ray has a mixture of 1% and 99% E2 with $\delta_{320} = +9.95 \pm 0.11$, and the 280 keV gamma- y has a mixture of 99% M1 and 1% E2 with $\delta_{280} = -0.11 \pm 0.11$.

8650 HINDERED E1 DECAY OF THE 6 keV INDIVIDUAL PARTICLE STATE OF $_{73}Ta^{181}$. U.Hauser.
clear Phys. (Internat.), Vol. 24, No. 3, 488-93 (May, 1961).
The half-life of the 6.25 keV first excited state of Ta^{181} was ermined by a delayed coincidence experiment with a time-to- se height conversion method and found to be $t_{\frac{1}{2}} = (6.8 \pm 0.4) \times 10^{-6}$. The E1 gamma transition probability of the state is smaller a factor of 5×10^5 than the single particle estimate in qualitative cord with Nilsson's asymptotic selection rules. The normalized nsition probability agrees within a factor of five with four other transitions occurring between levels of neighbouring nuclei ich are predicted to be almost identical according to the unified ory.

8651 $\gamma-\gamma$ ANGULAR CORRELATION IN THE $Ti^{48}(n,\gamma)Ti^{49}$ REACTION. B.Kardon, D.Kiss, I.Lovas and Z.Zámori.
clear Phys. (Internat.), Vol. 24, No. 1, 151-9 (April, 1961).
The angular correlation of the γ-radiation resulting from the $^8(n,\gamma)T^{49}$ reaction was measured for 0.34-1.38 MeV and 8-6.43 MeV cascades. The spin values of the 1.38 and 1.72 MeV els of Ti^{49} as well as the multipolarity of the 0.34 MeV transition re determined.

INTERNAL CONVERSION FROM μ-MESON CAPTURE IN YDROGEN. See Abstr. 8473

8652 LOW-ENERGY CONVERSION ELECTRONS OF Ag^{106} AND Rh^{106}; Pd^{106} LEVELS. W.G.Smith.
ys. Rev. (USA), Vol. 122, No. 5, 1600-5 (June 1, 1961).
The low-energy (less than 0.935 MeV) conversion electrons itted in the decays of Ag^{106} and Rh^{106} were observed in two manent-magnet electron spectrographs. A total of 29 transitions re observed in the Ag^{106} decay; 2 transitions were observed in the Rh^{106} decay. These data and the gamma scintillation results of Robinson et al. (Abstr. 15563 of 1960) on the same decays were used to postulate the following levels (in MeV) in Pd^{106}; 0, (0+); 0.5116, (2+); 1.1272, (2+); 1.1331, (0+); 1.2287, (4+); 1.5568, (3,4+); 1.7020, (2+); 1.9310, (3,4+); 2.0825, (3+); 2.3040, (3,4+); 2.3489, (3,4+); 2.3636 or 1.9469, (3,4,5+); 2.7336, (5,6+); 2.7540, (5+); and 2.9494, (5,6+). The proposed level scheme indicates that ~5%, ~85%, and ~10% of the electron capture of Ag^{106} proceeds to the 2.9494, 2.7540, and 2.7336 MeV levels, respectively.

8653 DECAY OF Cl^{34m}.
T.Tōhei.
J. Phys. Soc. Japan, Vol. 15, No. 3, 372-6 (March, 1960).
The gamma rays following the decay of Cl^{34} were studied with a scintillation spectrometer using a 4 in. diam. ×4in. NaI(Tl) crystal and a Sunvic 100 channel pulse height analyser. Samples were produced with a betatron by the $Cl^{35}(\gamma,n)Cl^{34}$ reaction. In the search,gamma rays of 1.17, 2.14, and 3.32 MeV and three weak gamma rays of 0.64, 0.77, and 4.10 MeV were found. The relative intensities were: I(1.17 MeV) : I(2.14 MeV) : I(3.32 MeV) : I(4.10 MeV) = 32 : 100 : 32 : 1.0.

8654 INVESTIGATIONS ON THE DECAY SCHEME OF I^{131} IN THE FLOW ENERGY REGION OF GAMMA-RAYS.
G.Máthé, T.Scharbert and D.Berényi.
Nuclear Phys. (Internat.), Vol. 24, No. 2, 318-21 (April, 1961).
The region below 364 keV energy of gamma radiation deriving from the decay of I^{131} was examined by scintillation techniques with ordinary as well as with sum-coincidence methods. A new cascade of 156-210 keV (of an intensity of ≅ 1% in relation to the cross-over transition) from a level of 364 keV into the ground state was found. Furthermore the existence of the 177 keV line was confirmed.

8655 HIGH ENERGY GAMMA RAYS IN THE DECAY OF 27h Ho^{166}.
P.G.Hansen, K.Wilsky, D.J.Horen and Lung-Wen Chiao.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 519-23 (May, 1961).
The gamma-ray spectrum of 27h Ho^{166} was re-investigated by means of a three-crystal pair-spectrometer and coincidence techniques. Two new gamma rays with energies of 1747 ± 5 and 1825 ± 5 keV establish a new level at 1826 keV in Er^{166}. The log ft value for the β-decay to this state is $5.2^{+0.3}_{-0.4}$ and suggests an allowed unhindered transition. Single particle assignments for this level are discussed.

8656 HALF-LIFE, Q_β VALUE, AND γ-RAY SPECTRUM OF La^{143}. K.Fritze, T.J.Kennett and W.V.Prestwich.
Canad. J. Phys., Vol. 39, No. 5, 662-7 (May, 1961).
The decay of La^{143} was investigated. A half-life of 14.0 ± 0.1 min and a Q_β value of 3.3 ± 0.1 MeV were found. The γ-radiation is weak and the spectrum is rather complex.

8657 ON THE DECAY OF THE ^{95}Tc ISOMER.
G.Chilosi, R.A.Ricci, G.Varcaccio and G.B.Vingiani.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1121-30 (March 16, 1961).
The γ-ray spectrum following the radioactive decay of the Tc^{95} isomer ($\tau_{\frac{1}{2}}$ = 62 day) was investigated by scintillation techniques. The sources were obtained by Mo(d,2n) reactions in the synchro-cyclotron of the Institute for Nuclear Physics Research in Amsterdam. The measurements were performed with a NaI(Tl) well-type crystal (76 mm × 76 mm) and the different spectra were displayed in a 200 channel analyser. $\gamma-\gamma$ cascades were investigated with a conventional coincidence set-up, using the summing technique. The direct disintegration of the isomeric state of Tc^{95} to the stable Mo^{95}, in competition with the 39 keV isomeric transition to the Tc^{95} ground-state, is confirmed. Excited levels of 1040, 820, 780 and 203 keV are assigned to the Mo^{95} structure, de-exciting mostly with the following transitions, in keV: 1040 (5 ± 1), 838 (38 ± 4), 820 (13 ± 2), 780 (17 ± 2), 580 (50 ± 5); 203 (100).

8658 THE LIFETIME OF THE 364 keV LEVEL IN ^{131}Xe.
W.D.Hamilton.
Proc Phys. Soc. (GB), Vol. 77, Pt 3, 610-16 (March, 1961).
The nuclear resonant scattering technique for γ-rays was used to measure the lifetime of the 364 keV level in Xe^{131}, and to determine the mixing ratio of the E2 + M1 ground state transition. Doppler broadening of the emission level, which compensates the recoil losses of the 364 keV γ-ray, is provided by the preceding 608 keV β^--transition from I^{131} when the source, methyl iodide, is in the gaseous phase, the scatterer being solid xenon. The measured lifetime of $(1.4 \pm 0.4) \times 10^{-11}$ sec is in agreement with Sunyar's

(1957) estimated value of 2×10^{-11} sec. A 0.34% M1 admixture was found for the 364 keV transition, and is of the order expected from internal conversion coefficient measurements.

8659 M1- TRANSITION IN V^{51} AND CONFIGURATION MIXING. T.Komoda.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 498-9.

The M1- transition probability of the 0.321 MeV level of V^{51} is calculated on the basis of configuration mixing. The calculated values are satisfactory in comparison with the experimental value of Delyagin and Preisa (Abstr. 11389 of 1960). For justification of the method, the magnetic moment of V^{51} is calculated. The result is almost in agreement with the experimental value.

8660 DECAY SCHEME OF E^{253}.
F.Asaro, S.G.Thompson, F.S.Stephens and I.Perlman.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 581-4.

The alpha decay of E^{253} leads to the identification in terms of the Nilsson model of three intrinsic Bk^{249} states. 12 alpha groups of E^{253} were observed corresponding to thee rotational bands based upon states at 0 keV, 7/2 + (633); 9 keV, 3/2 - (521); and 393 keV, 5/2 + (642). The rotational level spacings are interpreted in terms of the coriolis interaction.

8661 ELECTRIC MONOPOLE ENHANCED 2+ → 2+ TRANSITIONS.
D.E.Durham, D.H.Rester and C.M.Class.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 594-8.

Five transitions assigned as $2^+ \rightarrow 2^+$ were observed in the internal conversion spectra of $Th^{230,232}$ and $U^{236,238}$ following Coulomb excitation with 5 MeV protons. Evidence from the K/L ratios and conversion line intensities, together with gamma-ray data available in the cases of Th^{232} and U^{238}, supports the assumption of E0 enhancement in four of these transitions.

8662 ANOMALOUS CONVERSION COEFFICIENTS IN Hf^{180m}, W^{182}, AND Re^{187}. W.F.Edwards and F.Boehm.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 598-600.

A calibration of a bent-crystal diffraction gamma-ray spectrometer relative intensity scale has been performed and an accuracy of 1 or 2% in the comparison of intensities of lines differing in energy by a factor as large as 2.5 is now attainable. By comparing the observed relative intensities of gamma-ray lines with relative intensities of corresponding conversion electron lines measured with a precision magnetic spectrometer, precise absolute conversion coefficients were derived for several transitions in Hf^{180}, W^{182} and Re^{187}.

8663 RELATIVE TRANSITION PROBABILITIES IN Dy^{160}.
G.T.Ewan, R.L.Graham and J.S.Geiger.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 603-5.

The relative transition probabilities from positive and negative parity levels in Dy^{160} were determined in a high-resolution study of the decay of Tb^{160}. Comparison of these measurements with the theoretical predictions of the unified model shows that appreciable band mixing is required in order to obtain quantitative agreement. The E2 transition probabilities from the positive parity levels also agree with the predictions of the Davydov and Fillipov model.

8664 ON THE BETA-DECAY SYSTEMATICS OF Hg–Tl ISOTOPES. R.K.Gupta and S.Jha.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 617-20.

The decay energies of thallium isotopes were measured. The beta-decay systematics [plotted according to Way and Wood (Abstr. 5931 of 1954)] show a break at neutron number 120. These systematics are used to calculate the probability for α-decay of Pb^{210}. A possible method for detecting an α-branch in Pb^{210} is suggested.

8665 191 keV TRANSITION IN Au^{197}.
M.C.Joshi and B.V.Thosar.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 623-5.

Gamma-transitions in Au^{197} were studied in a beta-ray spectrometer, using $e-\gamma$ and $\beta-\gamma$ coincidence measurements. The K-conversion coefficient for the 191 keV transition was determined from the γ-spectrum in coincidence with L-conversion electrons of the 77 keV γ-ray. a_K is found to be 2.0 ± 0.5, which is interpreted as due to a $(M_1 + E_0)$ type of transition; the 268 keV level has spin $\frac{1}{2}$ and even parity.

8666 THE EFFECT OF NUCLEON PAIR CORRELATIONS ON THE PROBABILITY OF ELECTROMAGNETIC TRANSITIONS. Yu.T.Grin'.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 769-71.

The probability of electric multipole transitions between states close to the Fermi surface is shown to be reduced by a factor $A^{-2/3}$ when pair correlations are included in the theory.
E.J.Burg

8667 TRANSITION PROBABILITIES OF CAPTURE GAMMA RAYS IN U^{239}.
D.J.Hughes, H.Palevsky, H.Bolotin and R.Chrien.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 771-4.

The relative transition probabilities were determined for the prominent 4.06 MeV radiative transition from ten levels in U^{239} populated by s-wave neutron capture. The transition probabilities display an average deviation of 12 ± 3% and are remarkably consta compared to an average deviation of 240% found for the reduced neutron widths of the same ten levels. The observed distribution of the γ-ray transitions corresponds to χ^2 distribution with 90 ± 30 degree of freedom.

NUCLEAR REACTIONS

(Including scattering by nuclei)

8668 REACTIONS AND SCATTERING OF CHARGED PARTICLES. P.C.Gugelot.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 157-68.

Review of recent work on elastic scattering of protons and deuterons, and inelastic scattering. Anomalous scattering is considered more closely by comparing (α, α') and (d, p) excitation curves for Ni^{58}, Ni^{60} and Fe^{56} together with (p, p') for Fe^{56}. Concludes that extreme care is needed in interpreting (p, d) and (d, p) reactions in terms of the excitation of single-particle levels.
E.J.Bu

8669 A UNIFIED THEORY OF NUCLEAR REACTIONS. Yu.V.Tsekhmistrenko.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 240-3.

A new formalism is suggested from which known mechanisms follow as special cases. The partial width for conerent scattering shown to be zero, as in Bohr's compound nucleus theory, and the energy structure of the amplitude is shown not to determine the reaction mechanism.
E.J.Burg

8670 DIRECT REACTION THEORIES. N.Austern.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 323-35.

Review paper. Includes report of work with E.Rost on (1) (α,α') at 43 MeV on Mg^{24} which compares adiabatic Fraunhofer theory with a DWB surface interaction, (2) C^{12} (d,α) fitted with DWB surface interaction and (3) (α,α') on A, C and Mg treated as cases of rotational excitation using exact DWB theory. The importance of surface interactions is discussed.
F.J.Bun

8671 COMPETITION BETWEEN DIRECT INTERACTIONS AND COMPOUND NUCLEAR PROCESSES. S.Yoshida
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 336-9; Disc., 339-40.

8672 ALLOWANCE FOR UNSTABLE FINAL PARTICLES IN NUCLEAR REACTIONS. A.I.Baz.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 342-3.

Reports the solution of the following problems, but gives no details: (1) the energy dependence of the cross-section for production of an unstable particle B near threshold; (2) the cross-section for the scattering Z(X, X)Z near the threshold for B production and (3) the energy distribution of the disintegration products of B in the reaction Z + X → Y + B.
E.J.Bur

8673 EFFECTS OF A RESONANCE ON DIRECT REACTIONS. B.Buck and G.R.Satchler.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 355-7.

The effect on a direct reaction of a compound nucleus resonance studied. Two resonance effects are considered: first, interrence between the resonant and direct amplitudes, and secondly a sonant elastic distortion in the waves used to calculate the direct nplitude itself. In $C^{12}(d,p)C^{13}$ at 4 MeV the latter is found to have gligible effect on differential cross-section and polarization.

8674 ANGULAR DISTRIBUTIONS AND POLARIZATION IN DIRECT REACTIONS. L.J.B.Goldfarb and R.C.Johnson.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 367-8.

General expressions are found for angular distributions and olarization for a variety of processes including the stripping deuterons and heavier particles and inelastic scattering. Use made of the distorted-wave Born approximation with spinependent distortion. The case $l = 0$ leads to selection rules for olarization depending on the nature of the spin-dependence of the stortion.

8675 A SIMPLE TREATMENT OF NUCLEAR DIRECT INTERACTION PROCESSES.
E.McCarthy and D.L.Pursey.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 381-4.

Physical arguments are used to predict the effect on differential oss-sections of various types of distortion of the wave-functions ed in the distorted-wave Born approximation treatment of direct teractions. A simple but fairly realistic model for α-particle ave-functions gives reasonable agreement with observed cross-ctions for (α, α') scattering.

8676 COLLECTIVE EFFECTS IN INELASTIC SCATTERING. W.T.Pinkston and G.R.Satchler.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 394-6.

Inelastic scattering is closely analogous to an electric multipole diative transition, and will show similar collective enhancement. in-flip transitions are little affected, the enhancement being found the non-spin-flip amplitudes. Such enhancement will modify the nclusions drawn about angular momentum coupling in the target cleus, especially in the p-shell, since these depend upon the ratio spin-flip to non-flip.

8677 THE COMPOUND NUCLEUS. T.Ericson.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 697-705; Disc., 706-9.

8678 DOUBLE STRIPPING REACTIONS. A.A.Jaffe.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 814-20; Disc., 821-3.

8679 ELASTIC AND INELASTIC DIFFRACTION SCATTERING. J.S.Blair.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 824-35; Disc., 835-7.

A simplified treatment based on the Drozdov and Inopin model r inelastic diffraction scattering from a black ellipsoid shows that e octupole angular distribution is in phase with the elastic cross-ction while the monopole and quadrupole cross-sections are out phase with the elastic diffraction pattern. The variation with ergy of elastic and inelastic α-scattering by Mg is analysed and e nuclear deformation compared with that from exact DWB calulations for several nuclei. E.J.Burge

8680 AN EXPERIMENTAL TEST OF THE STATISTICAL THEORY OF NUCLEAR REACTIONS. D.L.Allan.
uclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 838-40; Disc., 840-2.

Reports the results of an experiment in which the compound ucleus phase of a reaction was deliberately exaggerated. ifferential (n, p) cross-sections in the backward direction (120°) of out 30 target nuclei were measured for 14 MeV incident neutrons sing a photographic plate method. The target nuclei were mostly in ie range A = 11 to 30. Excellent agreement with the statistical ieory was found for most of the even–odd and odd–even target uclei; equally good agreement could be obtained for even–even nuclei provided a pairing energy parameter δ is introduced into the calculations. The values of δ required to achieve agreement are close to those given by Cameron. Several formulae for the level density ρ were examined, and best agreement was obtained when the Lang and Le Couteur formula and the expression $\rho = \exp 2(aU)^{1/2}$ with $a = A/10$ were used.

8681 SIMPLIFIED DISCUSSION OF BACKWARD PEAKING IN DIRECT INTERACTIONS.
A.J.Kromminga and I.E.McCarthy.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 36-42 (April, 1961).

A systematic semi-quantitative understanding of the shape and energy variation of the large backward peaks often observed in the angular distributions of products of direct interactions is given by the distorted wave Born approximation for a normal stripping-type process. The peaks are seen to result from the overlapping of the foci in the optical model wavefunctions for the positive energy particles as the scattering angle approaches 180°. The energy variation has the same period as would be given by $[j_L(kr_o)]^2$ but it is displaced considerably in phase.

COULOMB EXCITATION OF VIBRATIONAL LEVELS. See Abstr. 8594

REACTIONS OF ORIENTED NUCLEI. See Abstr. 8646

8682 γ RAYS FROM AN EXTRANUCLEAR DIRECT CAPTURE PROCESS. R.F.Christy and I.Duck.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 89-101 (April, 1961).

Direct electric dipole capture γ-ray transitions are calculated for a number of cases of charged particle capture in nuclei. It is found that when the γ-ray energy is sufficiently low — below about 2 MeV — the capture matrix element is determined by regions external to the usual "nuclear radius". A number of cases of this type are discussed and the calculations compared with experiment. The calculations are extended to the keV region in those cases when the process is of astrophysical interest.

8683 DIRECT NUCLEON–NUCLEON COLLISIONS INSIDE THE NUCLEUS ACCORDING TO THE IMPULSE APPROXIMATION. L.Winsberg and T.P.Clements.
Phys. Rev. (USA), Vol. 122, No. 5, 1623-30 (June 1, 1961).

Direct nucleon–nucleon collisions play an important role in high-energy nuclear reactions. The importance of such collisions at lower energies is not clear. To aid in the interpretation of nuclear reactions, authors analysed the collisions between an incident nucleon and nucleons in a Fermi gas by means of the impulse approximation. The treatment is based on information from nucleon–nucleon scattering experiments. Collisions inside a nucleus are considered to be the same as those in the unbound state at the same centre-of-mass energy, except for the effect of the Pauli exclusion principle. The effective elastic and inelastic cross-section, (σ), between like and unlike nucleons is computed for incident energies from 10 MeV to 6 BeV at several values of the Fermi energy. The properties of the struck nucleons in allowed collisions are also calculated. This information may prove useful in interpreting some recoil experiments. Analytical expressions for (σ) and quantities related to the struck nucleon are given for elastic collisions in which the scattering is isotropic and the free-particle cross-section are either constant or vary inversely as the bombarding energy.

Due to Photons

8684 PHOTONUCLEAR REACTIONS — EXPERIMENTAL. L.Katz.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 710-20.

8685 THEORIES OF GIANT DIPOLE RESONANCES. J.S.Levinger.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 721-30.

8686 ON THE POSITION OF THE GIANT RESONANCE IN THE DIPOLE ABSORPTION OF PHOTONS BY MEDIUM WEIGHT NUCLEI. V.G.Neudachin, V.G.Shevchenko and N.P.Yudin.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 732-5.

Uses empirical data to take into account the residual pair

interactions and the binding energy of the nucleons in the closed shells. Ca^{40} and V^{51} are considered, and also, less reliably, Ni^{58}, Cu^{63} and Cu^{65}. E.J.Burge

8687 ON THE MECHANISM OF PHOTONUCLEAR REACTIONS. A.M.Badalian and A.I.Baz.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 739-40.

Reports, without details, that the statistical model cannot satisfactorily explain photonuclear reaction cross-sections. Qualitative explanations are claimed to be possible in terms of "threshold states", i.e. one-particle states of the intermediate nucleus near any two-particle threshold. E.J.Burge

8688 YIELD AND ANGULAR DISTRIBUTION OF FAST PHOTONEUTRONS. R.G.Baker and K.G.McNeill.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 740-3.

The yields and angular distributions of the fast (direct) photoneutrons from 25 medium and heavy nuclei were measured using silicon threshold detectors. Systematic variations of both the yield (A_0) and the coefficient a_2 of $W(\theta) = A_0(P_0 - a_2P_2)$ are interpreted in terms of the Wilkinson shell model (Abstr. 1973 of 1958) of electric dipole photonuclear direct interactions.

8689 THE PHOTODISINTEGRATION OF Be^9. W.Bertozzi, P.Demos, S.Kowalski, F.Paolini and C.Sargent.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 746.

The neutron spectra which result from the photodisintegration of Be were measured by time-of-flight for a series of eleven bremsstrahlung energies ranging from 5 to 17 MeV. The data indicate that the total cross-section is the sum of three partial cross-sections, corresponding to (γ,n) processes which leave Be^8 in its ground state and in its 2.9 MeV excited state, and a (γ,a) process which leaves He^5 in its lowest state. Features of these partial cross-sections are described.

8690 PHOTONUCLEAR ACTIVATION CROSS-SECTIONS AT 20.5 MeV. W.del Bianco and W.Stephens.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 746-8.

Cross-sections were measured for (γ,n) reactions on eight nuclides, leading to a position activity whose annihilation radiation could be counted with a pair of NaI crystals in coincidence. The gamma rays were furnished by the $T^3(p,\gamma)He^4$ reaction, and the targets used were C^{12}, F^{19}, Cr^{50}, Fe^{54}, Cu^{63}, Zn^{64}, Mo^{92}, and Sb^{121}.

8691 LONG RANGE CORRELATIONS AND PHOTO EFFECT IN NUCLEI. W.Brenig.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 751-3.

The velocity c of the Goldhaber–Teller collective mode in the photoeffect (Abstr. 659 of 1949) is shown to be connected with the structure factor s(k) of nuclear matter by $s(k) = k/2mc$. s(k) is calculated in the "random phase approximation". The value obtained for c is larger than the semi-classical one (Migdal–Jensen–Steinwedel) and in better agreement with shell-model configuration-mixing calculations.

8692 SCATTERING OF PHOTONS BY DEFORMED NUCLEI. E.G.Fuller and E.Hayward.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 763-6.

The relationship between various recently published expressions of the scattering cross-section for photons by deformed nuclei is given. The existence of a sum rule is pointed out. This shows that if the scattering is measured in poor resolution so as to include the nuclear Raman scattering all dependence of the scattering cross-section on the nuclear spin is eliminated.

8693 PHOTONEUTRON DISINTEGRATION BELOW THE GIANT RESONANCE: BERYLLIUM-9 AND CARBON-13. D.T.Goldman, N.C.Francis and E.Guth.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 766-9.

The direct-interaction photoneutron cross-sections of Be^9 and C^{13} are calculated using single-particle bound states and distorted continuum states. The beryllium results just above threshold agree quite well with the available experimental data. The s- and d-wave photoneutron cross-sections in C^{13} are calculated using potential-well parameters that describe $n-C^{12}$ scattering. The cross-section is about a factor of 3 larger than experiment.

RATIO OF THE DIFFERENTIAL (e,N) TO THE TOTAL (γ,N) EFFECTIVE CROSS-SECTION. See Abstr.8701

8694 COHERENT SCATTERING OF 1.17 MeV AND 1.33 MeV GAMMA RAYS THROUGH SMALL ANGLES. P.P.Kane and G.M.Holzwarth.
Phys. Rev. (USA), Vol. 122, No. 5, 1579-84 (June 1, 1961).

The dependence of the differential cross-section for the coherent scattering of 1.17 and 1.33 MeV gamma rays on atomic number was investigated. An empirical procedure, which makes an absolute determination of the cross-sections unnecessary, was used to estimate the Compton scattering cross-sections. The latter were subtracted from the measured cross-sections in order to obtain the relative coherent scattering cross-sections, which were found to vary as Z^n. The average value found for n is 3.07 ± 0.18. The angular distribution of the total (coherent and Compton) scattering cross-section was also investigated in the case of copper and lead between 2.43^0 and 5.79^0. The results are compared with the existing theoretical predictions and with the results of the earlier experiments, wherever the latter are available.

8695 SCATTERING CROSS-SECTIONS OF GAMMA RADIATION. V.Lakshminarayana and S.Jnanananda.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 593-8 (March, 1961).

Total cross-sections of gamma rays from sources Co^{60}, Sc^{46}, Cs^{137}, G^{51} and Ce^{141} in the elements graphite, aluminium and copper were determined, using a scintillation spectrometer of good figures of merit and modified narrow beam geometry. The values of total scattering cross-section were obtained by subtracting the theoretical values of photoelectric and pair cross-sections from the total experimental values. For energies greater than 320 keV good agreement is observed between theoretical and experimental values of total scattering cross-section, while at the energy 145 keV definite deviations are observed. The deviations are ascribed to the overestimation of total scattering cross-section by the use of atomic charge distribution predicted by the Thomas–Fermi model.

8696 NOTE ON THE PHOTOPARTICLES' ANGULAR DISTRIBUTION. A.Molinari.
Nuovo Cimento (Italy), Vol. 18, No. 6, 1298-1300 (Dec. 16, 1960).

An expression for the angular distribution in photonuclear interactions is obtained using the classical approximation. This is evaluated for a specific example and it is found that the anisotropic term in the angular distribution is in agreement with experiment for low energy photoneutrons, but is too small for high energy photoparticles. A.M.Gre

8697 PHOTONEUTRON REACTIONS IN C^{12} AND O^{16}. J.P.Roalsvig, I.C.Gupta and R.N.H.Haslam.
Canad. J. Phys., Vol. 39, No. 5, 643-56 (May, 1961).

Absolute yields of the reactions $C^{12}(\gamma,n)C^{11}$ and $O^{16}(\gamma,n)O^{15}$ were determined at 22 MeV maximum bremsstrahlung energy using the University of Saskatchewan 24 MeV betatron. For the reaction $C^{12}(\gamma,n)C^{11}$ a yield curve from threshold to 24 MeV was obtained and the cross-section curve for the reaction computed. A thorough comparison with other results was made.

PHOTOPRODUCTION OF PIONS IN CARBON. See Abstr. 8482

8698 ABSORPTION AND SCATTERING OF PHOTONS BY HOLMIUM AND ERBIUM. E.G.Fuller and E.Hayward.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 760-3.

The neutron production cross-section and the differential elastic scattering cross-sections at 90^0 are given for holmium and erbium. The former cross-sections are essentially identical and show clearly the splitting of the giant resonance resulting from the large intrinsic deformations of these nuclei. The analysis of the two experiments indicates a large tensor polarizability for these nuclei.

8699 FURTHER STUDY OF THE REACTION $^7Li(\gamma t)^4He$. M.Miwa and M.Yamanouchi.
J. Phys. Soc. Japan, Vol. 15, No. 6, 947-51 (June, 1960).

The reaction was studied by using betatron bremsstrahlung and nuclear emulsion. Resonance peaks were found in the excitation function at 7.8, 8.9, 9.8 and 13.5 MeV, in agreement with those fou

reviously by Miwa (1955). From the angular distribution analysis, is concluded that the spin and the parity of the 8.9 MeV level in i^7 is 5/2+.

8700 PHOTOPROTONS PRODUCED BY 245 ± 15 MeV GAMMA RAYS ON CARBON. R.J.Cence and B.J.Moyer.
Phys. Rev. (USA), Vol. 122, No. 5, 1634-9 (June 1, 1961).

A carbon target was bombarded by 342 MeV bremsstrahlung rom a synchrotron. The energy spectrum of protons produced at 0 deg was measured from 90-250 MeV. Interactions due to 45 ± 15 MeV gamma rays were selected out by requiring a coincidence between the protons from the target and the electrons associated with these gamma rays. Analysis was made using the quasi-euteron model of Levinger (Abstr. 9709 of 1951). In contrast with revious analyses of this kind, conservation of both momentum and nergy were taken into account in a fairly accurate way. Results f this analysis determine the momentum distribution of the centres f mass of the quasi-deuterons. The momentum distribution that esults in the observed proton spectrum, normalized to one quasi-euteron, is given by

$$\frac{d^3N}{dP_D^3} = \frac{0.2}{(4\pi ME_1)^{3/2}} \exp\left(-\frac{P_D^2}{4ME_1}\right) + \frac{0.8}{(4\pi ME_2)^{3/2}} \exp\left(-\frac{P_D^2}{4ME_2}\right),$$

where $E_1 = 1.6$ MeV, $E_2 = 20$ MeV.

Due to Electrons

8701 RATIO OF THE DIFFERENTIAL (e,N) TO THE TOTAL (γ,N) EFFECTIVE CROSS-SECTION. R.Rodenberg.
. Phys. (Germany), Vol. 162, No. 4, 34[illegible]-57 (1961). In German.

The ratio is derived using the relativistic Coulomb eigenfunc-ons for the continuous spectrum. For electric and magnetic dipole ansitions, the Born approximation, the Coulomb correction, the ffect of screening and that of finite nuclear size are calculated. In is angular distribution there should be no interference of electron aves scattered by different multipoles, where the inelastically cattered electrons are detected. Numerical calculations were ade for nuclei with Z = 6, 29, and 82 and scattering angles = 1°, 132°, 160° and 180° of the electron. The result of this theory compared with the experiments of Barber et al. (Abstr. 449 of 960).

8702 COMPARISON OF THE SCATTERING OF POSITRONS AND ELECTRONS FROM NUCLEAR CHARGE DISTRIBUTIONS. G.H.Rawitscher and C.R.Fischer.
hys. Rev. (USA), Vol. 122, No. 4, 1330-7 (May 15, 1961).

Elastic scattering cross-sections of 183 MeV positrons and ectrons are calculated for various charge distributions of the Ca id Au nuclei. It is shown that the combined use of positron and ectron scattering measurements can lead to a determination of the iclear charge distribution which is more accurate than that derived om either one of the scattering cross-sections when used by itself. he scattered particles obey Dirac's equation and the nuclei are sumed to be static spherically symmetric charge distributions, hose radial dependence is given in terms of a three-parameter mily of curves.

Due to Nucleons

8703 POLARIZATION IN THE ELASTIC AND INELASTIC SCATTERING OF NUCLEONS. L.Rosen.
clear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 185-93; Disc., 194-6.

This review of recent work includes preliminary results, shown graphical form, for polarization of elastically scattered protons 8.5 MeV from 30-150° for 15 elements, and for 30 elements at .5 MeV. Optical-model fits are shown for 15 elements at .5 MeV for the differential cross-section and for polarization.
E.J.Burge

8704 NUCLEON INDUCED DIRECT INTERACTIONS. R.M.Eisberg.
iclear structure conference, Kingston, Ontario, 1960 (see Abstr. 53 of 1961) p. 310-18; Disc., 319-22.

INTERACTIONS OF TeV NUCLEONS IN EMULSION.
See Abstr. 7238

Due to Protons

8705 ELASTIC SCATTERING OF 5.4 MeV PROTONS AGAINST THE ISOTOPES Ni^{64}, Zn^{64} AND Zn^{68}.
L.I.Bolotin, A.P.Kliutcharev, E.I.Revutzkii and N.Ya.Rutkevitch.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 169-73; Disc., 179-84.

The measured angular distributions resemble those of odd-mass nuclei and are compared with earlier results for $Cr^{52,53}$ and $Ni^{58,60,62}$. Large backward-angle scattering is obtained when the (p,n) threshold is above the energy of the incident protons and is explained as compound elastic scattering.
E.J.Burge

8706 ELASTIC SCATTERING OF 6.8 MeV PROTONS AGAINST ISOTOPES OF CHROMIUM, NICKEL AND COPPER. A.K.Val'ter, I.I.Zaliubowskii, A.P.Kliutcharev, M.V.Pasetchnik, N.N.Putcherov and V.I.Tchirko.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 173-6; Disc., 178-84.

Angular distributions from 20°-160° were obtained for $Cr^{52,53}$, $Ni^{58,60,62}$ and $Cu^{63,65}$. At backward angles, Cr^{52}, Ni^{58} and Ni^{60} have relatively large cross-sections.
E.J.Burge

8707 ELASTIC SCATTERING OF 6.8 MeV PROTONS BY ATOMIC NUCLEI.
M.V.Pasetchnik, N.N.Putcherov, I.E.Kashuba and V.I.Tchirko.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 176-9; Disc., 179-84.

Angular distributions from 20°-160° were obtained for targets of Al, Fe, Co, Ni, Cu, Zn, Ag, Cd, Sn, Pb and Bi with natural isotopic consistency.
E.J.Burge

8708 PROTON TOTAL REACTION CROSS-SECTION FOR COPPER AT 9.3 MeV. G.W.Greenlees and O.N.Jarvis.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 217-20.

A measurement of 930 ± 70 mb was obtained for the proton total reaction cross-section for copper at 9.3 ± 0.3 MeV by a poor-geometry transmission method not involving counter coincidence techniques. This result is appreciably higher than values predicted by published optical model analyses using a volume absorption term and indicates the need of either a surface absorption or a larger radius for the volume absorption.

8709 ELASTIC AND INELASTIC SCATTERING OF PROTONS BY OXYGEN AND NEON. S.Kobayashi.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 223-5.

Extensive experimental results are presented, showing the variation with energy from 6.9 to 15.6 MeV of the absolute angular distribution.

8710 SCATTERING OF PROTONS FROM LIGHT-MEDIUM-WEIGHT EVEN–EVEN NUCLEI. K.Matsuda.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 225-8.

Results are given of elastic and inelastic scattering, to the first 2^+ state. The elastic scattering shows the typical diffraction pattern in this mass and energy region (7-16 MeV).

8711 SCATTERING OF PROTONS FROM LIGHT EVEN–EVEN NUCLEI. K.Matsuda.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 228-31.

Results of angular distribution studies over a wide energy range are presented. The elastic and inelastic scattering of protons from C, O, Ne and Mg was investigated from 7 to 16 MeV.

8712 CHARGED PARTICLE AND TOTAL REACTION CROSS SECTIONS FOR PROTONS AT 9.85 MeV.
V.Meyer and N.M.Hintz.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 231-4.

The total yield of charged particles was measured for various nuclei. The bulk of the emitted particles have energy and angular distributions consistent with statistical theories. The total reaction cross-sections obtained are considerably higher than current

optical model values. Either a surface peaking or an increased radius for the imaginary potential seems necessary to explain the data.

8713 ELASTIC AND INELASTIC SCATTERING OF PROTONS FROM CARBON NUCLEUS FROM 6.5 MeV TO 16 MeV. Y.Nagahara.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 234-7.

Reaction yields were found to vary gradually with energy, but several distinct anomalies were observed, for example, at T_p = 9.1, 10.5 and 13.2 MeV. In the gradually varying regions, the angular distributions exhibited stable patterns which might be explained with the optical potential (Q = 0 reaction) and the direct interaction theory (Q = – 4.43 reaction). Rather strong correlations were observed between Q = 0 and Q = 4.43 reactions, which could be attributed to the very small reaction yields via the other channels. Anomalies correspond to the level structure of the compound nucleus N^{13}.

8714 NEUTRONS FROM (p, n) REACTIONS IN SEVERAL INTERMEDIATE WEIGHT NUCLEI. T.W.Bonner and R.L.Bramblett.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961). p. 347-9.

Energy spectra and angular distributions of neutrons were measured for (p, n) reactions in several intermediate weight nuclei at a proton bombarding energy of 5 MeV. The data indicate that the contribution of direct interaction is less than 0.3% of the total cross-section for the nuclei studied.

8715 THE NEUTRON YIELD FROM THE $C^{13}(pn)N^{13}$ REACTION. P.Dagley, W.Haeberli, J.X.Saladin and R.R.Borchers.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 359-61.

The 0^0 cross-section for the $C^{13}(p,n)N^{13}$ reaction was measured from threshold to 13.1 MeV and 50 angular distributions were determined in the same range. The yield at 90^0 was measured up to 5.3 MeV. The angular distributions show strong similarities and the results are discussed in terms of compound-nucleus and direct-interaction processes.

8716 COULOMB EFFECTS IN THE DIRECT INTERACTION. N.M.Hintz.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 368-70.

A direct-interaction model is used to calculate $\sigma(p, p')/\sigma(p, n)$ for events which leave the nucleus in a state with excitation $E \leq 8$ MeV. By including Coulomb forces in the interaction the high experimental ratio of inelastic protons to neutrons can be partially understood. The relative importance of Coulomb effects in the direct interaction is shown to increase with increasing bombarding energy.

8717 QUASI-FREE SCATTERING OF PROTONS. G.Jacob.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 429-33.

Reports experiments by Tyren, Hillman, Isacsson and Maris using 185 MeV protons, and by Tyren and Isacsson using 440 MeV protons. The (p, 2p) reaction for Na^{23} revealed 2s and 1d shells with 15 MeV binding energy and a p-peak near 22 MeV. The s-peak at 35 MeV for C^{12} and the 25 MeV peak for Li^7 were stronger at 440 MeV than at 185 MeV. The s-peak for He^4 was measured at several angles. Angular correlation distributions were found for Li^7 at 185 and 440 MeV for s- and p- protons, and for C^{12} at 440 MeV. At zero momentum transfer a dip is seen in the p-curve as expected.
E.J.Burge

8718 QUASI-FREE p–p SCATTERING IN MEDIUM AND HEAVY NUCLEI. G.Jacob and T.A.J.Maris.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 433-7.

It is shown that a certain type of non-coplanar quasi-free proton–proton scattering on heavy and medium nuclei is able to give direct and clear information on the structure of the target nucleus and the mechanism of the interaction. It is expected that the parities and orbital angular momenta of the occupied single-particle states in the least bound shell, and for some cases in the stronger bound shells, can be determined. In addition the radial extension of the surface interaction zone and its distance from the centre of the nucleus would follow immediately from the expected interference patterns.

9719 ALPHA PARTICLES FROM THE REACTION $Li^7(p, \gamma)Be^{8*}(\alpha)He^4$. D.S.Gemmell.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 482-5.

The α-particle spectrum was determined in coincidence with γ-rays. The results indicate that, apart from the broad 2.9 MeV level, there are no additional levels between the ground state and 7 MeV with intensities greater that 3% of the 2.9 MeV level. It is shown that the shape of the 2.9 MeV level can be fitted satisfactorily by a dispersion formula if a large value for the reduced width of the level is assumed.

8720 SEARCH FOR PROTON SIZE RESONANCES. E.A.Almqvist, D.A.Bromley, J.A.Kuehner and E.W.Vogt.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 736-9.

A measure of the total proton reaction cross-sections for protons of energy 4-12.9 MeV on Mg, Al, Ti, Fe, Co, Ni, Ni^{58}, Cu, Zn and V targets was obtained by examining all gamma radiation ($E_\gamma \geq 600$ keV) associated with the bombardments. These data were subjected to optical model analysis; satisfactory fits were obtained except in cases involving the shell closure (N or Z = 28). The presence of a combined S and D wave size resonance for ~7.0 MeV protons on Ni is confirmed.

8721 DIPOLE EXCITATION OF C^{12} IN THE INELASTIC SCATTERING OF 156 MeV PROTONS. P.Benoist-Gueutal.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 743-6.

ΔJ = 1, yes, ΔT = 1 excitation of C^{12} in the inelastic scattering of 156 MeV protons is calculated in the impulse approximation, showing the competition between the photonuclear giant resonance mainly excited by the Coulomb forces and another dipole collective state excited in a spin-flip scattering of the proton which gives the major contribution for angles of scattering $>6^0$.

8722 GIANT RESONANCE REGION OF EXCITATION IN Ne^{21}. C.Broude and H.E.Gove.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 754-7.

The 90^0 yield of gamma rays leading to the ground and first excited state of Ne^{20} and of alpha particles to the ground state of O^{16} were measured using the reactions $F^{19}(p, \gamma)Ne^{20}$ and $F^{19}(p, \alpha)O^{16}$ in the proton energy range from 4 to 11 MeV. A number of broad resonances with 100 keV spacing appear in the gamma yield. In the alpha yield narrower resonances appear with their envelope correlated with the gamma yield to some extent.

8723 HIGH ENERGY γ RAYS FROM LEVELS EXCITED IN THE GIANT RESONANCE REGION BY INELASTIC SCATTERING OF 150 MeV PROTONS. N.Marty, H.Langevin and X.de Bouard.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 774-6.

150 MeV protons excite in light nuclei a peak in the giant resonance region. Looking for high-energy γ-rays in coincidence with inelastic scattered protons from these peaks in C^{12} and O^{16}, the authors found about 1.5 γ-rays for 10^3 such protons, indicating 1^- excitation. The γ-rays seem not to have the same energy for protons scattered at 10^0 and 25^0.

8724 ELASTIC AND INELASTIC SCATTERING OF PROTONS FROM N, Ne, Mg, Si, S AND A IN THE ENERGY RANGE FROM 7.6 MeV TO 14.2 MeV. Y.Oda, M.Takeda, N.Takano, T.Yamazaki, C.Hu, K.Kikuchi, S.Kobayashi, K.Matsuda and Y.Nagahara.
J. Phys. Soc. Japan, Vol. 15, No. 5, 760-71 (May, 1960).

The angular distributions of protons scattered elastically and inelastically by N, Me, Mg, Si, S and A nuclei were studied at several values of proton energy from 7.6 to 14.2 MeV. The distribution shapes for elastic scattering show generally diffraction patterns at $E_p > 10$ MeV. While the yields of inelastic scattering corresponding to the second excited state of N^{14} are appreciable at higher energies, the yields for the first excited state with T = 1 are markedly low. The inelastic scatterings for the first excited states of Ne^{20}, Mg^{24} and Si^{28} are found to change their distribution shapes appreciably with proton energy. The excitation functions of the reaction for Si^{28} were also studied. The results show prominent resonance features. These results seem to support the view that the formation of compound nucleus plays an appreciable role in the inelas

cattering from these light nuclei, especially at the lower energy. he distribution shapes of the inelastic scattering from S^{32} are irly insensitive to energy change. Further, the inelastic scatter- g of protons from A^{40} shows quite a different feature from those entioned above. The angular distribution shapes and their energy ependences resemble much those obtained for medium weight ven—even nuclei.

8725 COULOMB EXCITATION OF THE SECOND 2+ STATES IN W, Os, AND Pt NUCLEI.
.K.McGowan and P.H.Stelson.
hys. Rev. (USA), Vol. 122, No. 4, 1274-80 (May 15, 1961)

The location of a second 2+ state was established for six ven—even nuclei by means of Coulomb excitation produced by 4 to MeV protons. The relatively weak excitation of these states is etected by a measurement of the gamma-ray yields from singles pectra and from coincident measurements of the cascade gamma ays. The B(E2)'s for decay of the second 2+ state to ground state the crossover transition exhibit some uniformity for the even— ven isotopes of W and Os, being about 6 times the single-particle alue. The cascade/crossover ratio for the decay of the second 2+ ate is known for these nuclei. The upper cascade B(E2)'s exhibit hancements of 10 to 60 times the single-particle value. The tios of the B(E2)'s for decay of the first and second 2+ states are mpared to the predictions of several collective models. For five these nuclei the E2/M1 ratio is known for the upper cascade ansition. The B(M1) values obtained are exceedingly small com- ared to the single-particle estimate. This result is in qualitative greement with the collective models which predict that M1 radi- ion is forbidden in the decay of vibrational excitations.

8726 RADII OF OPTICAL-MODEL POTENTIALS IN PROTON SCATTERING AT 183 MeV. P.E.Hodgson.
hys. Rev. Letters (USA), Vol. 6, No. 7, 358-60 (April 1, 1961).

The results of optical-model calculations of the differential ross-section, polarization and reaction cross-section for proton cattering by various nuclei at 160 MeV are discussed and compared ith experiment. It appears to be necessary to have the radius of he imaginary central part of the potential about 30% greater than hat of the real central part, for medium weight nuclei, in order to btain good agreement. E.J.Squires

8727 PROTON CAPTURE IN A^{40}.
S.E.Arnell.
uclear Phys. (Internat.), Vol. 24, No. 3, 500-4 (May, 1961).

The $A^{40}(p,\gamma)K^{41}$ reaction was studied in the range of proton nergies from 700 to 1400 keV using electromagnetically separated otopes. Fifty-seven excited levels in K^{41} were observed. The rget problem was given special attention.

8728 ENERGY SPECTRUM AND ANGULAR DISTRIBUTIONS OF NEUTRONS FROM THE REACTION $Be^9(p,n)B^9$ AT TO 14 MeV OF PROTON ENERGIES. Y.Saji.
Phys. Soc. Japan, Vol. 15, No. 3, 367-71 (March, 1960).

The $Be^9(p,n)B^9$ reaction was studied by using a fast neutron ectrometer with a hydrogen gas radiator. The energy spectrum neutrons from the reaction at 14.1 MeV of proton energy was tained and three new excited levels (3.07, 4.14 and 4.94 MeV) in were observed. They are consistent with the levels of the mirror cleus, Be^9, and the level scheme of intermediate coupling model troduced by Kurath. Moreover, the angular distributions of the $^9(p,n)B^9$ neutrons at 8.1 to 14.1 MeV of proton energies were tained. The results do not agree with the theory of Austern, Butler d McManus. The isotropic parts of the neutron angular distribu- ons become larger as the incident proton energies decrease. It probably due to the fact that, in the lower energy region, the rmation of compound nucleus is more preferable.

8729 THE $C^{13}(p,n)N^{13}$ REACTION CROSS SECTION FROM THRESHOLD TO 13 MeV.
.Dagley, W.Haeberli and J.X.Saladin.
uclear Phys. (Internat.), Vol. 24, No. 3, 353-71 (May, 1961).

The cross-section for the $C^{13}(p,n)N^{13}$ reaction was measured 0^0 from threshold to 13.1 MeV and at 90^0 from threshold to 5.3 eV. Resonances were observed, some of which can be attributed known states in N^{14}. No indication was found of a neutron group ading to the first excited state in N^{13} but above 8 MeV there is idence for neutrons leading to the second or third excited state. the energy range between threshold and 13 MeV fifty angular stributions of the neutrons leading to the ground state of N^{13} were determined. The angular distributions are similar in shape over energy intervals of two or three MeV. At the end of an interval the angular distributions change character quite suddenly. Over much of the energy range there is pronounced backward peaking with a secondary maximum near 50^0 and no forward peak. Above 11.4 MeV the angular distributions are in qualitative agreement with a simple direct interaction calculation. The differential cross-sections were integrated to give the total cross-section for the reaction.

$C^{14}(p,n)N^{14}$ AND $C^{14}(p,\gamma_0)N^{15}$ REACTIONS FOR PROTON ENERGIES OF LESS THAN 1.6 MeV. See Abstr. 8624

8730 THE REACTIONS $Li^7(p,n)Be^7$, $B^{11}(p,n)C^{11}$ AND $Al^{27}(p,n)Si^{27}$ AT 8 TO 14 MeV. K.Hisatake, Y.Ishizaki, A.Isoya, T.Nakamura, Y.Nakano, B.Saheki, Y.Saji and K.Yuasa.
J. Phys. Soc. Japan, Vol. 15, No. 5, 741-8 (May, 1960).

The reactions were studied by using two kinds of proton-recoil, fast-neutron spectrometers. One is an addition type originated by Calvert, Jaffe and Maslin, the other is a type with hydrogen gas radiator. The angular distributions of $Li^7(p,n)Be^7$ neutrons corresponding to the ground and the 0.43 MeV excited states doubles at 8.1 to 14.1 MeV of proton energies and corresponding to the 4.65 MeV excited state of Be^7 at 14.1 MeV of proton energy were obtained. Using the activation method, the excitation curve of this reaction was observed with 15 MeV proton beam. The angular distributions of neutrons from the reaction $B^{11}(p,n)C^{11}$ (the ground state) at 8.1 to 14.1 MeV and from the reactions $Al^{27}(p,n)Si^{27}$ (the ground and the excited states) at 14.1 MeV of proton energy were also observed. The theory of Austern, Butler and McManus (1953) does not agree with the obtained results in the case of the reaction $B^{11}(p,n)C^{11}$, but agrees with that in the reaction $Al^{27}(p,n)Si^{27}$. It was observed that, for the reaction $B^{11}(p,n)C^{11}$, the isotropic parts of the angular distributions of neutrons became larger as the incident proton energies decreased and, in the cases of the reactions of $Li^7(p,n)Be^7$ and $B^{11}(p,n)C^{11}$, the angular distributions of neutrons showed large variations for the different proton energies.

8731 CROSS-SECTION FOR THE REACTIONS (p,n) AND (p,2n) ON Nd^{150}. J.Olkowsky, I.Gratot and M.Le Pape.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 84-8 (April, 1961).
In French.

Absolute cross-sections were measured for the reactions $Nd^{150}(p,n)Pm^{150}$ and $Nd^{150}(p,2n)Pm^{149}$ ($E \leq 11.1$ MeV). The sum of these cross-sections is compared to that obtained by means of the optical model. The agreement is satisfactory. By using a simple model of evaporation, theoretical excitation functions are obtained, which render a good account of experimental results.

$Si^{29}(p,\gamma)P^{30}$ REACTION: LEVELS IN P^{30}. See Abstr. 8576

8732 THE $C^{12}(p,pn)C^{11}$ AND $Al^{27}(p,3pn)Na^{24}$ CROSS-SECTIONS AT 591 MeV.
K.Goebel, D.Harting, J.C.Kluyver, A.Kusumegi and H.Schultes.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 28-35 (April, 1961).

The absolute cross-sections of the reactions $C^{12}(p,pn)C^{11}$ and $Al^{27}(p,3pn)Na^{24}$ were measured by exposing polythene and aluminium targets to the 591 MeV external proton beam of the CERN synchro-cyclotron. The proton flux was measured with a secondary emission chamber, calibrated by a counter telescope technique. The C^{11} and Na^{24} activity, induced in the targets, was determined by conventional counting methods, using calibrated Na^{22} and Na^{24} sources as primary standards. The measured cross-sections are 29.9 ± 1.5 mb and 11.0 ± 0.5 mb for the reactions $C^{12}(p,pn)C^{11}$ and $Al^{27}(p,3pn)Na^{24}$ respectively.

Due to Neutrons

8733 ELASTIC AND INELASTIC SCATTERING OF NEUTRONS. M.Walt.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 146-56.

Data on fast neutron scattering are reviewed in terms of the optical model.

8734 THE $Fe^{56}(n,n'\gamma)$ REACTION AND COMPARISON TO THEORY. D.M.Van Patter and R.W.Jackiw.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 244-6.

$Fe^{56}(n,n'\gamma)$ spectra were measured for $E_n = 1.0$-3.3 MeV at

$\theta = 100^0$ from a Fe ring scatterer. Inelastic neutron cross-sections are obtained after correction for the angular distribution of the 0.845 MeV γ-ray, and are compared to theoretical predictions using various diffuse surface potentials. Comparisons with theory are also made for the excitation of individual levels up to 3.12 MeV in Fe^{56}.

8735 DIRECT-INTERACTION CONTRIBUTION TO 3 MeV NEUTRON INELASTIC SCATTERING FROM Fe AND Pb.
L.Cranberg and N.K.Glendenning.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 357-9.

The presence of direct interactions in neutron inelastic scattering appears to begin to contribute to the excitation of the first states in Fe^{56} and Pb^{206} at 3 MeV. The angular distributions show a small preference for forward-hemisphere scattering compared to symmetric distributions at 2.2 MeV. The direct-interaction theory is in qualitative (though not detailed) agreement with the nonsymmetric component.

8736 DISTORTED WAVE BORN CALCULATION FOR INELASTIC SCATTERING OF 14 MeV NEUTRONS.
F.G.J.Perey.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 387-91.

The inelastic differential cross-sections were measured for scattering of 14 MeV neutrons from the first levels of C^{12}, O^{16}, and Li^7. The differential cross-sections were calculated using the distorted-wave Born approximation. It was possible to find very good agreement with the shape of the experimental cross-sections using a reasonable set of optical potential parameters. The results of the calculations using square-well and rounded-edge potentials are presented.

8737 NEUTRON SCATTERING FROM CLOSED SHELL NUCLEI. J.L.Fowler, E.G.Corman and E.C.Campbell.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 474-7.

The role of phase shifts of neutron scattering used in combination with bound state information in defining phenomenological nuclear potentials is illustrated for the case of O^{16}. Various forms of the potential are compared. Data on the total neutron cross-section of Pb^{208} from 0.55 to 4.32 MeV show up a great many new resonances.

8738 ANOMALOUS INTENSITIES OF PRIMARY NEUTRON CAPTURE γ-RAYS. G.A.Bartholomew.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 573-6.

The reduced intensities of competing primary capture γ-rays of a given multipolarity emitted in transitions to low excited states in various heavy nuclei fluctuate by as much as two orders of magnitude. While a K-selection rule explanation might be entertained in some cases, it is not sufficient in W^{183}, where some support for a direct capture mechanism is found.

8739 A COMPARISON OF THE NEUTRON CAPTURE γ-RAY SPECTRA OF Gd^{156} AND Gd^{158}.
J.W.Knowles, G.Manning, G.A.Bartholomew, and P.J.Campion.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 576-80; Disc., 80.

The neutron capture γ-ray spectra of Gd^{156} and Gd^{158} at $\leq 1\%$ resolution show considerable differences in detail. These differences may imply significant level structure differences above 1.2 MeV.

8740 SLOW NEUTRON RESONANCES.
J.A.Harvey.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 659-73; Disc., 673-5.
Review.

8741 PARAMETERS OF NEUTRON RESONANCES IN U^{238} + n UP TO 1.8 keV.
F.W.K.Firk, J.E.Lynn and M.C.Moxon.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 757-60.

Parameters of 100 resonances in U^{238} + n were determined using a general method of area analysis. A strength function $\langle \Gamma_n^0 \rangle_{Av}/D = (1.00 \pm 0.15) \times 10^{-4}$ is obtained. The reduced neutron widths have a Porter–Thomas distribution with $\nu = (1.02 \pm 0.12)$ degress of freedom. A Wigner distribution of level spacings is indicated.

8742 SINGLE PARTICLE EFFECTS IN (n,p) SPECTRA OF MEDIUM WEIGHT NUCLEI. R.A.Peck, Jr.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 783-6.

Spectra of five (n,p) reactions on nuclei from Rh to Sb are presented. Some common gross structure appears, showing dips at the single neutron energy gaps corresponding to magic numbers 82 and 126; energy displacements of the spectra agree with separations of the ground state neutron configurations computed from the Nilsson model.

8743 COUPLED SQUARE WELL MODEL FOR ELASTIC SCATTERING. D.E.Bilhorn and W.Tobocman.
Phys. Rev. (USA), Vol. 122, No. 5, 1517-20 (June 1, 1961).

For previous work, see Abstr. 1445 of 1960. A simple model for s-wave neutron scattering is provided by representing the scattering potential by a pair of coupled square wells. Such a model produces resonances that exhibit the giant resonance effect. Isolated resonances given by this model for two types of coupling are compared with the Breit–Wigner formula. It is found that for a resonance with a width of about 16 keV, the resonant part of the scattering does indeed have the Breit–Wigner form. The resonance energy is found to be considerably shifted from the energy of the bound state that exists in the zero-coupling-strength limit. Also the nonresonant part of the scattering amplitude is considerably different from both the hard-sphere scattering amplitude and the zero-coupling-strength limit scattering amplitude. This last result is in accord with expectations based on R-matrix theory.

SCATTERING OF FAST NEUTRONS BY N^{15}. See Abstr. 8590

NEUTRON SCATTERING ON Na^{23}: LEVELS IN Na^{24} AT 350-630 keV. See Abstr. 8626

8744 ACTIVATION CROSS SECTIONS FOR (n,p) REACTIONS IN SOME MEDIUM-WEIGHT NUCLEI WITH D + D NEUTRONS. J.J.van Loef.
Nuclear Phys. (Internat.), Vol. 24, No. 2, 340-5 (April, 1961).

Activation cross-sections for (n,p) reactions d + d neutrons are reported on Fe^{54}, Ni^{61} and Zn^{67} and compared with previously published (n,p) cross-sections in Fe^{56}, Ni^{58} and Zn^{64}. The (n,p) cross-sections of the even target nuclei are much greater than those of the odd neutron nuclei; among even nuclei they are highest for 28 closed shell Fe^{54} and Ni^{58}.

8745 FAST NEUTRON ACTIVATION CROSS SECTION OF Au^{197}. S.A.Cox.
Phys. Rev. (USA), Vol. 122, No. 4, 1280-4 (May 15, 1961).

The neutron activation cross-section of gold was measured in the neutron range from 30-1500 keV. The absolute value of the cross-section was based on the U^{235} fast fission cross-section which was used for absolute neutron flux measurements from 200-1500 keV. For measurements below 200 keV, the $B^{10}(n,\alpha)$ cross-section was used for monitoring the neutron flux. The relative cross-section from 30-200 keV was then normalized at 200 keV to the absolute measurement. The results agree well with recent measurements, except for some pulsed beam–liquid scintillator measurements and spherical shell transmission measurements which yield much lower cross-section values.

8746 INVESTIGATIONS OF THE REACTION $Cl^{35}(n,\gamma\gamma')Cl^{36}$.
J.E.Draper and A.A.Fleischer.
Phys. Rev. (USA), Vol. 122, No. 5, 1585-9 (June 1, 1961).

Two-step gamma-ray cascades to the ground state of Cl^{36} following thermal-neutron capture by Cl^{35} were investigated with a sum-coincidence apparatus. The direct experimental result is the produce $I_1 b_2$ of the intensity I_1 of the initial transition and the branching factor b_2 of the intermediate state to the ground state. The quantity b_2 is separately deduced from auxiliary information about I_1. The lower-energy members of the strong cascades occur at 0.79, 1.16, 1.60, 1.96 and 2.87 MeV with respective values of $I_1 b_2$ of 8.2, 11.6, 2.9, 12.1, and 5.1 per 100 neutrons captured. Weaker cascades appear at 2.2, 2.48, 2.6, 2.68 and 3.05 MeV. Cascades appearing between 3.3 and 4.3 MeV have $I_1 b_2 \leq 0.5\%$. The b_2 following the strongest of all initial transitions, viz., 6.11 MeV, is only ≤ 0.02. Approximately 46% of all neutrons captured produce two-step cascades in Cl^{36}.

$F^{19}(n,\alpha)N^{16}$ REACTION: LEVELS IN N^{16}. See Abstr. 8577

8747 ABSOLUTE CROSS SECTION OF THE $K^{39}(n,p)A^{39}$ REACTION FOR 2.5-MeV NEUTRONS.
.R.Dixon and J.H.Aitken.
uclear Phys. (Internat.), Vol. 24, No. 3, 456-64 (May, 1961).

The cross-section for the $K^{39}(n,p)A^{39}$ reaction, at a neutron ıergy of 2.46 MeV, was measured to be 96 ± 6 mb. The experiental method consists of taking coincidences between the events a KI(Tl) scintillation crystal and the He^3 particles which are roduced simultaneously with neutrons in the d–d reaction.

8748 PROTONS AND DEUTERONS FROM Ni^{58} BOMBARDED BY 14.8 MeV NEUTRONS. R.N.Glover and K.H.Purser.
uclear Phys. (Internat.), Vol. 24, No. 3, 431-42 (May, 1961).

Using a counter telescope, energy spectra and angular distriutions are measured for protons emitted from Ni^{58} at 14.8 MeV ıcident neutron energy. The angular distributions indicate for the irect interaction contribution $l = 0$ and $l = 2$ transitions to unreolved levels near the ground state of the residual Co^{58} nucleus. ransitions with $l = 1$ to states of higher excitation demonstrate ıe presence of odd parity levels. Below 6 MeV proton energy, the istributions are isotropic. Nuclear temperatures of 1.35 ± 0.03 leV and 0.05 ± 0.03 MeV are found for the reactions (n,pγ) + (n,pn) nd (n,np) respectively. The total cross section for proton emission s 830 ± 70 mb. Partial cross-sections are: (n,pγ) + (n,pn) 430 mb ompound nucleus, 60 mb direct interaction; (n,np) 340 mb. Deuteron mission is established, the total cross-section for the (n,d) reaction eing 25 ± 6 mb. The angular distribution of the most prominent euteron group suggests unresolved transitions to the $\frac{7}{2}^-$ Co^{57} ground tate and a new state at approximately 0.5 MeV. The presence of n $l = 1$ transition implies approximately 13% p-wave admixture in ıe Ni^{58} ground state configuration.

8749 THE PICK-UP REACTION ON THE NUCLIDES ^{45}Sc, ^{51}V, ^{52}Cr, ^{54}Fe, ^{56}Fe, ^{55}Mn, ^{59}Co, ^{58}Ni, ^{60}Ni.
.Colli, I.Iori, S.Micheletti and M.Pignanelli.
uovo Cimento (Italy), Vol. 20, No. 1, 94-103 (April 1, 1961).

Energy spectra of deuterons from (n,d) reaction on elements elonging to the $f_{7/2}$ proton shell are presented. Deuteron peaks orresponding to the fundamental and some excited levels of the esidual nucleus are brought into evidence. A comparison between elative experimental intensities of ground state transitions, and ıose predicted on the basis of the shell model hypothesis and the utler's pick-up mechanism for the n,d reaction is made. The greement found is satisfactory.

Due to Mesons and Hyperons

8750 EXPERIMENTAL METHOD FOR THE DETERMINATION OF THE EFFECTIVE CROSS-SECTIONS FOR SIMPLE CATTERING AS A FUNCTION OF THE ATOMIC NUMBER Z SING NUCLEAR EMULSIONS.
[.Avan, J.Faïn, L.Hugon and P.Y.Bertin.
.R. Acad. Sci. (France), Vol. 252, No. 8, 1138-40 (Feb. 20, 1961).
ı French.

Mo, Ag and Pt wires and Ag-plated Cu and Au wires of 5-40 μ diameter were embedded in 500 μ Ilford G5 emulsion and ıe whole exposed to 15-18 GeV/c π-mesons and cosmic-ray -mesons. The differential cross-sections out to 15° were meaıred. The use of isothermal development at 8°C reduced the ɔurious scattering ($\bar{\alpha}$) for Au wires to 5' compared with 21' for the ɜual method with a hot stage at 28°C. E.J.Burge

8751 NUCLEAR REACTIONS IN COLD HYDROGEN. I. MESONIC CATALYSIS.
a.B.Zel'dovich and S.S.Gershtein.
spekhi fiz. Nauk (USSR), Vol. 71, No. 4, 581-630 (Aug., 1960).
ı Russian.

The catalysis of nuclear reactions in hydrogen by μ-mesons ıs been detected by both visual and electronic techniques. The ɔrmation of μ-mesic atoms when μ-mesons are captured by hydroɔn leads eventually to the formation of "mesomolecules". When ıch a molecule contains a deuterium nucleus there is a relatively ıgh probability that a nuclear fusion reaction, with a release of ıergy, will take place within the molecule. The existence of a elf-limiting process does not allow practical applications of this ffect but it can nevertheless be very interesting from the point of .ew of nuclear physics. Furthermore, a detailed knowledge of such rocesses is important since they must be taken into account in experimental studies of the weak interactions of μ-mesons in hydrogen. A systematic survey of the relevant experimental and theoretical results is given, including a discussion of the mechanism of formation and the properties of mesomolecules and calculations of nuclear reaction probabilities. In conclusion, several experiments are suggested which would give further useful information about specific processes occurring as a result of the μ catalysis.
[English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 4, 593-623 (Jan.-Feb., 1961)]. J.D.Dowell

Due to Deuterons

8752 ELASTIC SCATTERING OF MEDIUM ENERGY DEUTERONS BY GOLD AND SILVER.
P.C.Gugelot, H.R.E.Tjin A Djie, W.D.Whitehead and F.J.de Heer.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 220-2.

The elastic scattering was studied between 10° and about 40° in the forward direction at 14.5, 17.2, 21.7 and 24.3 MeV. In the angular distribution for gold the deviation from the Rutherford behaviour starts at a well defined angle. This angle can be derived with the help of a semiclassical picture, assuming the possibility of disintegration of the deuteron in the Coulomb field.

8753 MECHANISM FOR REACTIONS INVOLVING MASS TWO AND THREE NUCLEI. D.A.Bromley.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 272-305; Disc., 305-9.

Reviews experimental data for reactions due to deutrons, He^3, and tritons. For deutron reactions, separate treatments are given of reduced widths, distorted wave effects, and polarization phenomena.

8754 LARGE ANGLE STRIPPING ANGULAR DISTRIBUTION FITTING. D.A.Bromley, J.A.Kuehner and E.Almqvist.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 349-52.

While plane-wave stripping formalism reproduces the diffraction structure observed in stripping angular distributions, the predicted envelope of this structure decreases much more rapidly with increasing angle than is observed experimentally. It has been observed that $Si^{29}(d,p)Si^{29}$ and $Al^{27}(d,p)Al^{28}$ data for both $l = 0$ and $l = 2$ are well fitted at large angles if a constant momentum transform of the deuteron wave-function is assumed. A number of deuteron potentials have been examined. It is demonstrated that no reasonable potential will produce such a form factor. It then appears necessary to attribute the augmented large-angle cross-sections to distorted-wave effects.

8755 DISTORTED WAVE EFFECTS IN STRIPPING.
D.A.Bromley, J.A.Kuehner and E.Almqvist.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 352-5.

Distorted-wave analysis is applied to Si^{28} $(d,p\gamma)Si^{29}$ angular correlations measured for the range E_d = 6 to 9 MeV. For D-wave neutron capture and E2 de-excitation of the 2.03 MeV state a single correlation in the reaction plane determines the statistical tensors. From these tensors the angular correlations of the 1.28 MeV state are predicted and are in accord with experiment, supporting the stripping hypothesis of independence of final-state nuclear structure.

8756 (dn) STRIPPING STUDIES ON B^{10} AND B^{11}.
A.J.Ferguson, H.E.Gove, A.E.Litherland and R.Batchelor.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 364-6.

The 6.50 MeV level of C^{11} and the 15.1 MeV level of C^{12} were studied through (d, n) stripping reactions on B^{10} and B^{11}. In both cases, P-wave patterns were observed indicating negative parity for the states. The proton reduced width of the 15.10 MeV level of C^{12} was found to be of the order of magnitude of the single-particle width.

8757 EXCITATION OF COLLECTIVE NUCLEAR LEVELS IN STRIPPING REACTIONS. A.M.Korolev.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 371-5.

Applies the phonon treatment of collective excitations in Born approximation to the (d, p) reaction for even–even spherical nuclei with a few nucleons outside the closed shell. A shift in the principal maximum is caused by a significant contribution to the angular distribution at large angles. E.J.Burge

8758 REDUCED WIDTH EXTRACTION FROM STRIPPING DATA.

J.A.Kuehner, E.A.Almqvist and D.A.Bromley.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 375-8.

Reduced widths have been extracted from the experimental data on the $Si^{28}(d,p)Si^{29}$ reaction using four separate techniques to examine the relative validity of these techniques. These are (a) fitting the absolute total cross-section, (b) fitting the differential cross-section in the region of the stripping maximum, (c) extrapolating the differential cross-section information to the pole of the plane-wave formalism as suggested by Amado, and (d) examining the ratio of coefficients of Legendre polynomial expansions fitted to both experimental and plane-wave theoretical differential cross-sections as functions of the polynomial order as suggested by Bowcock. All results lie within a factor of 2, providing further justification for use of the simple peak fitting procedure.

8759 INTERFERENCE EFFECTS IN STRIPPING.
J.A.Kuehner, E.Almqvist and D.A.Bromley.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 378-81

High resolution studies on the $Si^{28}(d,p)Si^{29}$ reactions for $6 \leq E_d \leq 11$ MeV have demonstrated pronounced interference structure in proton differential excitation curves for both S and D wave neutron-capture situation. Corresponding proton angular distributions have established a dominant direct interaction mechanism; the interference (involving direct and compound system amplitudes) does not appear in the total excitation curve. Relative reaction intensities of $> 85\%$ and $< 15\%$ have been established for the direct and compound system contributions in this energy range. The total excitation curves are well fitted by a simple, plane-wave Butler formalism.

8760 STRIPPING REACTIONS OF LOW Q-VALUE.
J.P.F.Sellschop and D.W.Mingay.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 396-9.

Differential cross-sections for the reactions $C^{12}(d,p)C^{13*}$ (3.09 MeV level) and $Li^7(d,p)Li^8$ (ground state) were measured for incident deuteron energies between 2.0 and 4.0 MeV. Angular distributions measured at low deuteron energies are extremely well fitted using the pure stripping formalism of Butler, the close agreement being attributed to the small Q values of the reactions

8761 POLARIZATION OF PROTONS FROM THE $B^{10}(d,p)B^{11}$(gnd) AND $Ca^{40}(d,p)Ca^{41}$(gnd) REACTIONS.
M.Takeda, S.Kato, C.Hu and N.Takahashi.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 400-2.

The proton polarizations were measured, using 11.4 MeV deuterons. The emitted proton energies were reduced to 15 MeV in order to use the ~55% polarization of carbon at 45°, and the protons were detected with NaI crystals. The negative polarizations observed are contrary to those expected from the Newns theory.

8762 (d,p) AND (d,t) REACTIONS AND PAIRING PLUS QUADRUPOLE–QUADRUPOLE FORCE MODEL.
S.Yoshida.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 657-8.

Cross-sections for (d,p) and (d,t) reactions in units of the single-particle cross-sections are calculated assuming the pairing plus quadrupole–quadrupole force. The ratio of the ground-state cross-section (odd → even–even) to (even–even → odd) nuclei and vibrational state to the ground state are compared with experiments on the Sn isotopes. Agreement is fairly good.

8763 ELASTIC AND INELASTIC SCATTERING OF 11.2 MeV DEUTERONS. M.Takeda.
J. Phys. Soc. Japan, Vol. 15, No. 4, 557-66 (April, 1960).

The differential cross-section for deuteron-nucleus elastic scattering was measured for N, O, Ne, Mg, Al, S, A, Ca, Cr, Fe, Ni, Cu, Kr, Ag, Xe and Au at the deuteron energy of 11.2 MeV. Measurements were done at 5° intervals from 15° to 165° with relative uncertainty of 3 to 5%. Deuterons were detected by a thin CsI(Tl) crystal whose energy resolution was about 4% so that in almost all the cases inelastic deutrons and protons produced from (d, p) reactions were rejected. The measured cross-sections show a pronounced diffraction pattern in light and medium weight nuclei. But the cross-sections for heavier elements show a smooth decrease and are smaller than the Rutherford cross-sections. The cross-sections of deuterons leading to the first excited state of Ne^{20} and Mg^{24} by inelastic scattering were obtained. However, inelastically scattered deuterons in other elements could not be detected. The angular distributions for Ne^{20} and Mg^{24} are explained by the direct nuclear process.

8764 (d, α) REACTIONS ON SOME LIGHT NUCLEI AT 13 MeV. N.Cindro, M.Cerineo and A.Strzałkowski.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 107-17 (April, 1961).

Angular distributions of alpha particles from the reactions $B^{10}(d,\alpha)Be^8$, $B^{10}(d,\alpha)Be^{8*}$, $F^{19}(d,\alpha)O^{17}$, $F^{19}(d,\alpha)O^{17*}$ were studied with 13 MeV deuterons by means of thin scintillator technique. The results of B^{10} and F^{19} show a forward peaked distribution. An attempted fit in terms of the Butler theory indicates the predominancy of direct processes in the mechanism of these reactions. The angular distribution for the reaction $Al^{27}(d,\alpha)Mg^{25}$ was also measured. In this case it was not possible separate the ground state from the low-lying excited states of Mg^{25}. The absolute values of differential cross-sections were measured in all cases.

LOW-LYING LEVELS OF C^{11} OBTAINED FROM $B^{10}(d,n\gamma)C^{11}$.
See Abstr. 8587

8765 THE POLARIZATION OF PROTONS $Be^9(d,p)Be^{10}$ AND $Li^6(d,p)Li^7$ FOR 1.63 MeV DEUTERONS.
A.M.K.van Beek and G.O.André.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 102-6 (April, 1961).

The degree of polarization of the ground state protons of Be^{10} when Be^9 is bombarded with 1.63 MeV deuterons, has been found to be $P = +1\% \pm 7\%$ at an angle of 40°. Although the statistics in the lithium reaction are very poor, the degree of polarization is estimated to be $-48\% \pm 16\%$ and $-63\% \pm 14\%$ for the ground state and first excited state protons respectively at 40°.

8766 DIFFERENTIAL CROSS SECTIONS FOR THE REACTION $C^{12}(d,p)C^{13}$ IN THE ENERGY RANGE OF DEUTERONS FROM 15- TO 20-MeV. S.Morita, N.Kawai, N.Takano, Y.Gotô, R.Hanada, Y.Nakajima, S.Takemoto and Y.Yaegashi.
J. Phys. Soc. Japan, Vol. 15, No. 4, 550-6 (April, 1960).

The angular distributions of protons from the reaction $C^{12}(d,p)C^{13}$ were measured at the deuterons energies of 14.9-, 16.6-, 18.1-, and 19.6- MeV, for the proton groups leading to the lowest four levels of C^{13}. The proton groups to the second and third excited states were not resolved. The measurements covered the angular range from 15 to 165 degrees at intervals of 7.5 degrees. The results were compared with the stripping theory and qualitative agreement in the forward directions was obtained, but not in the backward. The best fits for the angular distributions of the ground state group were obtained with the nuclear radius of $(6.3 \pm 0.1) \times 10^{-13}$ cm with Bhatia's formula (1952). The angular distributions changed regularly with the deuteron energy. The excitation function was found to decrease monotonically with the increase of deuteron energy but that in the backward directions showed a slower decrease than that for the forward directions.

8767 (d,α) REACTIONS ON C^{12}, O^{16} AND Mg^{24}.
F.Pellegrini.
Nuclear Phys. (Internat.), Vol. 24, No. 3, 372-87 (May, 1961).

The energy spectra of alpha particles from bombardment of C^{12}, O^{16} and Mg^{24} with 15 MeV deuterons were measured at many angles between 10° and 90° (laboratory system) by means of an ionization chamber with a resolution in energy of about 1.2%. The alpha groups leading to the 1.74 MeV, T = 1, 0+ level of B^{10} and to the 2.31 MeV, T = 1,0+ level of N^{14} were not observed. The 2.22 MeV level of Na^{22} was slightly excited for angles of observation less than 40° (laboratory system) but for higher angles it appeared with an intensity comparable with the intensity of other T = 0 levels of Na^{22}. Angular distributions and absolute cross-sections corresponding to the ground, 0.72, 2.15 and 3.58 MeV states of B^{10} to the ground state of N^{14} and to the ground 0.58, 0.89, 1.53 and 2.58 MeV states of Na^{22} are reported. The general shape of these angular distributions indicates that the (d,α) reactions, leading to the low lying states of the residual nuclei, proceed by a direct surface interaction. Attempts to fit the data with plane and distorted wave calculation were made.

8768 THE $C^{13}(d,n)N^{14}$ REACTION.
A.N.James.
Nuclear Phys. (Internat.), Vol. 24, No. 1, 132-7 (April, 1961).

The time of flight method was used to measure angular distributions and excitation functions for the neutrons emitted to form the ground and first six excited states of N^{14} in the $C^{13}(d,n)N^{14}$ reaction

ne properties of the 4.91 and 5.69 MeV N^{14} levels were consistent ith the weak coupling configuration ($C^{13}2s_{1/2}$). The nature of the 10 and 5.83 MeV levels remains in doubt.

8769 $Ce^{140}(d,p)Ce^{141}$ REACTION.
G.B.Holm and H.J.Martin, Jr.
hys. Rev. (USA), Vol. 122, No. 5, 1537-41 (June 1, 1961).

Eight proton groups were observed, leading to levels in Ce^{141} t excitation energies of 0, 0.65, 1.12, 1.35, 1.47, 1.77, 2.15, and .41 MeV. Angular distributions and relative cross-sections were sed to make the following assignments: $\frac{7}{2}$ - for the ground state, - for the 0.65 MeV state, $\frac{3}{2}$ - for the 1.12 MeV state; $\frac{5}{2}$ - for the .77 MeV state, and $\frac{1}{2}$- for the 2.41 MeV state.

PROTON GROUPS FRON $Na^{23}(d,p)Na^{24}$. See Abstr. 8572

8770 (d,p) REACTIONS IN DEFORMED HEAVY NUCLEI.
G.B.Holm, J.R.Burwell and D.W.Miller.
hys. Rev. (USA), Vol. 122, No. 4, 1260-6 (May 15, 1961).

The spectra of protons from (d,p) nuclear reactions initiated 11 MeV deuterons incident on Th^{232}, U^{233}, U^{235}, U^{238} and Pu^{239} ere obtained using separated isotopic targets. The protons were nalysed in a double-focusing magnetic spectrometer. States with ssignments known from radioactive-decay studies are identified d assignments for some other observed states are discussed sing the Nilsson model and Satchler's theory (Abstr. 4259 of 1959) (d,p) reactions in deformed nuclei. From an analysis of the sults the following binding energies of the last neutron are btained: U^{234}, 6.83 ±0.11 MeV; U^{239}, 4.74 ± 0.06 MeV; and Pu^{240}, 49 ± 0.05 MeV.

Due to Alpha-particles

8771 ELASTIC AND INELASTIC SCATTERING OF ALPHA PARTICLES BY CARBON.
.Mikumo, H.Yamaguchi, I.Nonaka, S.Hitaka, T.Maki, M.Mukai and .Nakajima.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 391-4.

Angular distributions of alpha-particles scattered elastically d inelastically (Q = -4.43 MeV) by carbon were measured at even alpha-particle energies between 27.0 and 35.5 MeV. The sults are summarized together with data of other authors. Both stributions show striking diffraction patterns and are quite nsitive to bombarding energies. They can not be explained by mple theories. Some qualitative features are pointed out.

8772 ISOBARIC SPIN SELECTION RULES AS DEMONSTRATED IN THE $Mg^{24}(\alpha,\gamma)Si^{28}$ REACTION.
.J.M.Smulders, P.B.Smith and P.M.Endt.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p. 516-18.

Spectra and angular distributions of the gamma radiation from ght resonances (E_α = 1.8 — 3.3 MeV) in the $Mg^{24}(\alpha,\gamma)Si^{28}$ reaction ere measured. Four of these resonances have $J^\pi = 2^+$, and three ave $J^\pi = 4^+$. They decay by almost pure E2 transitions. This emonstrates the strong suppression of dipole radiation in the self-onjugated nucleus Si^{28}.

8773 THE EVAPORATION OF PROTONS FROM RAPIDLY ROTATING NUCLEI.
Bodansky, R.K.Cole, W.G.Cross, C.R.Gruhn and I.Halpern.
uclear structure conference, Kingston, Ontario, 1960 (see Abstr. 153 of 1961) p.749-51.

A large yield of coincident protons (about 550 mb) is observed scintillation counter studies of the $(\alpha,2p)$ reaction in Ni^{58} at 32 eV. Cross-sections and energy and angular distributions are aracteristic of evaporation from a rotating compound nucleus. ne distributions, which are symmetric about 90°, are much more isotropic than estimated for rigid-body rotation.

8774 THE ELASTIC SCATTERING OF 29 MeV He^3 BY Al, V AND Cu.
W.Greenlees, J.S.Lilley, P.C.Rowe and P.E.Hodgson.
uclear Phys. (Internat.), Vol. 24, No. 2, 334-9 (April, 1961).

Absolute differential cross-sections are presented for the gular range 15°–80° (c.m.). The results are fitted by an optical odel potential with a Saxon–Woods form factor and no spin orbit rm.

ALPHA-RAY INELASTIC SCATTERING ON Al^{27}.
ee Abstr. 8618

8775 ELASTIC AND INELASTIC SCATTERING OF ALPHA PARTICLES BY N^{14}. W.D.Ploughe.
Phys. Rev. (USA), Vol. 122, No. 4, 1232-4 (May 15, 1961).

The absolute differential cross-section for the elastic and inelastic scattering of 19.2 MeV alpha particles by N^{14} was measured as a function of the scattering angle. The forward part of the ground-state angular distribution was fitted with the black-nucleus diffraction model of Blair using an interaction radius of 5.89×10^{-13} cm. The angular distribution for the Q = − 3.95 MeV group was fitted with $[j_2(qR)]^2$ using an interaction radius of $R = 5.9 \times 10^{-13}$ cm. With the same interaction radius, a best fit to the data for the unresolved doublet, Q = − 4.91 and −5.10 MeV, was obtained using the sum $[j_1(qR)]^2 + [j_3(qR)]^2$. The best fit by odd-order spherical Bessel functions is consistent with the assignment of negative parity to both the 4.91 and 5.10 MeV levels.

8776 REACTIONS OF ARGON-40 WITH ALPHA-PARTICLES.
S.Tanaka, M.Furukawa, T.Mikumo, S.Iwata, M.Yagi and H.Amano.
J. Phys. Soc. Japan, Vol. 15, No. 6, 952-6 (June, 1960).

Excitation functions for the (α, p) and (α, pn) reactions on A^{40} were measured by the activation method using a "modified stacked-foil" technique. The bombardments were made with an alpha-particle beam from the 160 cm INSJ cyclotron. The beam was collected in a Faraday cup and measured by a current integrator. The disintegration rates of product nuclei were determined by $4\pi\beta$-counting. The results were compared with the predictions based on the statistical model of nuclear reaction by use of a level density expression of the form $\omega = c \exp[2(aE)^{1/2}]$. The experimental cross-sections appear to agree with the calculated values for $r_0 \cong 1.1 \times 10^{-13}$ cm and $a = 1 \sim 2$ MeV^{-1}. The considerably low value of r_0 might indicate that the statistical model is not completely applicable.

8777 EXCITATION FUNCTIONS FOR THE $(\alpha, \alpha n)$ AND $(\alpha, 2pn)$ REACTIONS ON Ce^{142}. B.M.Foreman, Jr.
Phys. Rev. (USA), Vol. 122, No. 4, 1283-5 (May 15, 1961).

Cross-sections were measured radiochemically for the reactions $Ce^{142}(\alpha, \alpha n)Ce^{141}$ and $Ce^{142}(\alpha, 2pn)Ce^{143}$ in the helium-ion energy range 16.8-40.1 MeV. The cross-section for the $(\alpha, \alpha n)$ reaction begins to rise sharply at about 25 MeV and reaches a value of 69 ± 5 mb at 40.1 MeV. The cross-section for the $(\alpha, 2pn)$ reaction begins to rise at about 32 MeV and reaches a value of 2.5 ±0.4 mb at 40.1 MeV. An upper limit of ~0.1 mb for the cross-section for the reaction $Ce^{142}(\alpha, \alpha p)La^{141}$ in the energy range covered by this study was also obtained. The results for the $(\alpha, \alpha n)$ and $(\alpha, \alpha p)$ reactions are discussed in terms of the following possible mechanisms: compound nucleus formation and decay, knock-on, and direct inelastic scattering followed by neutron evaporation. The results seem to be most consistent with the last mechanism. The existence of a measurable cross-section for the $(\alpha, 2pn)$ reaction in this energy region suggests that the reaction proceeds mainly by He^3 emission, probably by a stripping mechanism. The data reported are consistent with the hypothesis that in this energy range at most one particle is emitted as a result of direct interaction.

8778 NEUTRON GROUPS FROM $K(\alpha, n)Sc$.
A.M.Smith and F.E.Steigert.
Phys. Rev. (USA), Vol. 122, No. 5, 1527-30 (June 1, 1961).

Neutron groups resulting from the alpha-particle bombardment of separated isotopes of potassium were observed. Ground-state Q values of −3.42 ± 0.06 MeV for $K^{41}(\alpha, n)Sc^{44}$ and −7.16 ± 0.06 MeV for $K^{39}(\alpha, n)Sc^{42}$ were obtained. A large number of excited states or groupings of states were also observed. The presence of chlorine in one of the targets permitted measurement of the $Cl^{37}(\alpha, n)K^{40}$ reaction as well. A ground-state Q value of −3.86 ± 0.06 MeV was obtained. A tentative value of −5.89 ± 0.06 MeV can be given for the $Cl^{35}(\alpha, n)K^{38}$ ground state.

8779 EXCITATION FUNCTIONS FOR ALPHA-INDUCED REACTIONS ON MANGANESE-55.
S.Tanaka, M.Furukawa, T.Mikumo, S.Iwata, M.Yagi and H.Amano.
J. Phys. Soc. Japan, Vol. 15, No. 4, 545-50 (April, 1960).

Excitation functions for the reactions $Mn^{55}(\alpha,n)Co^{58}$, $Mn^{55}(\alpha,2n)Co^{57}$, $Mn^{55}(\alpha,3n)Co^{56}$, $Mn^{55}(\alpha,\alpha'n)Mn^{54}$ and $Mn^{55}(\alpha,2pn)Mn^{56}$ were measured by the activation method using a "stacked-foil" technique, the alpha-particle energies ranging from 10 MeV to 40 MeV. Bombardments were made with the alpha-particle beam of 32 MeV and 40 MeV from the 160 cm INSJ cyclotron. The beam was collected in a Faraday cup and measured by a current integrator. After bombardments, manganese, cobalt and iron were chemically separated. The disintegration rates of product nuclei Co^{58}, Co^{57}, Co^{56} and Mn^{54} were obtained by gamma-ray scintillation spectro-

metry, while that of Mn^{56} by a calibrated end-window type Geiger counter. The reaction cross-section was found to agree with calculated value for a nuclear radius constant r_0 of 1.7×10^{-13} cm. Competition between different reactions was analysed in terms of the statistical model of nuclear reaction by use of a level density expression of $\omega = c \exp[2(aE)^{1/2}]$ and it agrees with the calculated value for $a = 2$ MeV^{-1}.

$N^{14}(He^3,n)F^{16}$ REACTION: LEVELS IN F^{16}. See Abstr. 8577

Due to other Particles and Nuclei

8780 OPTICAL MODEL ANALYSES OF HEAVY ION SCATTERING. R.H.Bassel and R.M.Drisko.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 212-14.

The optical model is applied to the scattering of medium-energy nitrogen ions from carbon and beryllium. Using the usual Saxon potential shape to represent the real well and either the Saxon shape or a Gaussian shape for the imaginary well, good fits to the experiments are found over a limited angular region.

8781 THE STUDY OF NUCLEAR STRUCTURE WITH HEAVY IONS. A.Zucker.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 247-54.

8782 RESONANT ELASTIC SCATTERING OF HEAVY IONS. D.A.Bromley, J.A.Kuehner and E.Almqvist.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 255-8.

The elastic scattering of C^{12} by C^{12}, O^{16} by O^{16}, and C^{12} by O^{16} was measured. Below the barrier excellent agreement with Mott scattering is obtained. At higher energies marked resonant interference structure is observed for C + C scattering but not for O + O scattering. The C + O case shows some structure. A quasi-molecular interaction mechanism is proposed.

8783 RESONANT REACTIONS INVOLVING HEAVY IONS. E.Almqvist, D.A.Bromley and J.A.Kuehner.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 258-61.

Excitation curves were measured for a number of reaction products including some or all of protons, alpha particles, neutrons and gamma radiation for carbon and oxygen ions on a number of target nuclei and for nitrogen ions on nitrogen. In the case of C + C, clearly defined resonances are observed for energies below the Coulomb barrier; for N + N only a single such resonance is found. No evidence for resonant structure is found in any other system studied including O + O. The quasi-molecular interaction postulated to explain the elastic scattering data is also in accord with these reaction results.

8784 QUASI-MOLECULAR RESONANCES IN $C^{12} + C^{12}$. J.A.Kuehner, B.Whalen, E.Almqvist and D.A.Bromley.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 if 1961) p. 261-7.

Measurements on the $C^{12} + C^{12}$ elastic excitation curves in the low-energy resonant region were carried out at centre-of-mass angles corresponding to zeros of the Legendre Polynomials $P_4(\cos\theta)$, $P_6(\cos\theta)$, $P_8(\cos\theta)$, $P_{10}(\cos\theta)$ as well as at 90°. Resonance fluctuations in these differential cross-sections, together with a knowledge of the resonance parameters as determined from reaction excitation curves, allow spin assignments to be made. The resonance at 5.98 MeV is assigned J = 4 and, with less certainty, that at 5.65 MeV is assigned J = 8.

8785 SOME (t, d) REACTIONS IN LIGHT NUCLEI AT 5.5 MeV. F.de S.Barros, P.D.Forsyth, A.A.Jaffe and I.J.Taylor.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 344-7.

Angular distributions and absolute cross-sections were measured for several deuteron groups emitted from targets of natural boron, carbon, silicon dioxide and aluminium bombarded with 5.5 MeV tritons. The results are compared with the available data on the (d, p) reactions between the same initial and final nuclear states.

DETERMINATION OF NUCLEAR SURFACE PARAMETERS BY MEANS OF THE ELASTIC SCATTERING OF LIGHT NUCLEI. See Abstr. 8545

$C^{14}(t,p)C^{16}$ REACTION. See Abstr. 7343

8786 THE EMISSION OF CHARGED PARTICLES FROM THE BOMBARDMENT OF SILVER WITH NITROGEN IONS. J.S.Lilley.
Proc. Phys. Soc. (GB), Vol. 77, Pt 4, 833-44 (April, 1961).

A silver foil of 4.4 mg cm^{-2} was bombarded with the internal $(N^{14})^{6+}$ beam from the 150 cm Birmingham cyclotron, and the reaction products were recorded in C2 emulsion. The energy and angular distributions of the emitted protons and α-particles were measured and the results at large angles was compared with the predictions of evaporation theory. Good agreement was obtained by assuming that the Coulomb barrier is reduced at high nuclear excitations. The presence of competing direct processes is discussed briefly.

Nuclear Fission

8787 FISSION PHENOMENA AND NUCLEAR STRUCTURE. I-II. J.J.Griffin; G.C.Hanna.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 843-61; 862-73.
Review.

8788 ON THE ENERGY OF EXCITATION OF FISSION FRAGMENTS. B.T.Geilikman.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 874-5.

Reports, without details, calculations based on the shell model with the Nilsson Hamiltonian. Points out that shell effects must be allowed for in the highly deformed nascent fragments. E.J.Bur

8789 THE KINETIC ENERGY OF FISSION FRAGMENTS FROM THE PHOTO-FISSION OF Th^{232} AND U^{238}. A.P.Komar.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 875-81.

A back-to-back ionization chamber was used to measure in coincidence the kinetic energy of fission fragments from the photo-fission of Th^{232} and U^{238} for $E_{\gamma max}$ = 70 MeV. (See also Bochagov et al., Abstr. 20510 of 1960). The probability contours are given for the E_1, E_2 plane. A triple humped mass yield curve with a sma central hump was found for Th^{232}. E.J.Bur

8790 THE RESONANCE ENERGY CROSS SECTION OF U^{233}. N.J.Pattenden and J.A.Harvey.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 882-4.

Accurate transmission measurements were made upon severa highly enriched metal foils of U^{233} (99.76%). The total cross-sectio data up to 25 eV were analysed using a multilevel resonance formu to allow for interference in fission. A good fit to the experimental data was obtained assuming a constant radiation width for the resonances, and two fission channels.

8791 FISSION FRAGMENTS FROM ORIENTED U^{233} AND U^{23} L.D.Roberts, F.J.Walter, J.W.T.Dabbs, G.W.Parker a J.O.Thomson.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr 2153 of 1961) p. 884-6.

Studies of fission fragment angular distributions from therma neutron induced fission of aligned U^{233} and U^{235} nuclei show an isotropic distribution from U^{233} and a moderate anisotropy (opposi in sign to the alpha-particle anisotropy) from U^{235}. These results are compared with Bohr's suggestion that K = 0 should be preferred. A strong preference of this type is not indicated.

8792 ANGULAR DISTRIBUTION OF FISSION FRAGMENTS INDUCED BY LOW ENERGY NEUTRONS. V.M.Strutinski.
Nuclear Structure Conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 887-9.

Obtains and examines a quantum-mechanical expression for th angular distributions of the fission fragments when the orbital moment of the low-energy neutron is comparable with the spin of the target nucleus. Suggests that the Gaussian distribution of K values, where K is the component of the spin of the compound nucle along the axis of symmetry (the direction of fission), is supported the experimental observation that the anisotropy is roughly inde-pendent of target spin. E.J.Bur

8793 DELAY NEUTRONS IN NUCLEAR FISSION. K.W.Hoffmann.
turwissenschaften (Germany), Vol. 48, No. 2, 36-9 (1961). German.

Brief review describing the observation and properties of delay utrons. The analysis of reactions leading to such neutrons, as ll as the measurement of half-lives and yields of the fission oducts, is discussed. S.J.St-Lorant

8794 SYMMETRIC AND ASYMMETRIC FISSION. H.W.Newson.
ys. Rev. (USA), Vol. 122, No. 4, 1224-6 (May 15, 1961).

Fission yields are calculated assuming as a first approximation that they are proportional to the product of the level densities a pair of binary fission products. The level densities are lculated with the simplified shell-model methods of Newson and ncan (Abstr. 13608 of 1959). The calculations predict a single mmetric peak when the mass of the fissioning nucleus, $= N_1 + Z_1 + N_2 + Z_2 = 50 + 28 + 82 + 50 = 210$ (in agreement with e observed fission yields for bismuth and lighter elements), and ee maxima in the fission yield curves for heavier compound clei. The peak corresponding to approximately equal-size binary ission products is very much higher than is observed experimently. This is undoubtedly due to the fact that in asymmetric fission core corresponding to 82 neutrons and 50 protons remains intact the heavier fission product whereas for symmetric fission this re is disrupted at the cost of several MeV. Since correction for e energy effect involves a number of unknown factors, the lculated yields for symmetric fission are reduced by the same mpirical factor in all calculations. An additional parameter, n, introduced in correcting for excitation energy of the fission oducts and for possible departures from equilibrium. These lculations, which involve only two free parameters, explain most the fission yield data for all five known cases where the compound cleus is within an MeV or so of the fission threshold: Pu^{239}, U^{238}, ^{35}, U^{233}, and Th^{232}, but it is necessary to treat n as a free parameter for each curve to fit the small steep regions on each side of ass number $\frac{1}{2}A_0$. The calculated fission yields of the more highly cited compound nucleus, Ac^{227}, predict three equally prominent axima, in qualitative agreement with observation.

8795 MECHANISM OF FISSION OF HEAVY NUCLEI. P.Fong.
ys. Rev. (USA), Vol. 122, No. 5, 1542 (June 1, 1961).

A question is raised concerning the validity of the Vladimirskii echanism of fission (Abstr. 5397 of 1958) in which the individual cleons with large component of angular momentum in the direction the symmetry axis give rise to instability against asymmetric formation and thus lead to an asymmetric saddle point.

8796 STATISTICAL THEORY OF NUCLEAR FISSION AND PROMPT NEUTRON DISTRIBUTION. P.Fong.
ys. Rev. (USA), Vol. 122, No. 5, 1543-4 (June 1, 1961).

It is shown that the statistical theory of nuclear fission (Abstr. 27 of 1953; 4629 of 1956) is consistent with the recent experimental results of prompt neutron distribution in fission [(Abstr. 8643 of 59 and Dobrynin et al., Atomnaya Energiya (USSR), Vol. 8, No. 1, (1960)] if one assumes the existence of some constraint in the ocess of approaching equilibrium which controls the partition of citation energy between the two fragments.

8797 NUCLEAR MODELS AND NUCLEAR FISSION. P.Fong.
ys. Rev. (USA), Vol. 122, No. 5, 1545-6 (June 1, 1961).

The hindrance to spontaneous fission by the odd nucleon in the sioning nucleus may be explained as due to the pairing energy of e odd nucleon at the saddle-point deformation.

8798 FISSION OF HEAVY NUCLEI WITH EMISSION OF LONG-RANGE α-PARTICLES.
A.Perfilov, Yu.F.Romanov and Z.I.Solov'eva.
pekhi fiz. Nauk (USSR), Vol. 71, No. 3, 471-83 (July, 1960). Russian.

Review of experimental work on the comparatively rare process ternary fission. The following conclusions are made: (1) The g-range particles emitted on this process are α-particles. Ternary fission with α-emission occurs in all the nuclei investied with a probability ~ 1/200 to 1/400 of that of binary fission. is relative probability has been measured for fission by thermal l fast neutrons, γ-rays and for spontaneous fission. (3) The ectrum of the α-particles consists of a broad peak centred about 17 MeV with a half-width ~ 12 MeV. (4) The angular distribution of the α-particles peaks at a region near 80° to the direction of the light fission fragment. Results for the energy distribution of the fragments accompanying the α-particles are discussed. Two models have been proposed to account for ternary fission, but it is pointed out that neither of them is in accord with all the experimental data. (English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 4, 542-50 (Jan.-Feb., 1961). R.E.Meads

8799 SYMMETRY OF NEUTRON-INDUCED U^{235} FISSION AT INDIVIDUAL RESONANCES. G.A.Cowan, A.Turkevich, C.I.Browne and Los Alamos Radiochemistry Group.
Phys. Rev. (USA), Vol. 122, No. 4, 1286-94 (May 15, 1961).

Neutrons in the resonance energy region from a nuclear explosion were resolved by time-of-flight and used to induce fissions in U^{235} attached to a revolving wheel. The symmetry of fission at individual resonances from approximately 10 to 60 eV was examined by radiochemical means. As measured by the ratio Ag^{111}/Mo^{99}, the probability of symmetric fission decreased at some resonances by a maximum of 10% compared to thermal fission of U^{235} and at other resonances increased by a maximum of 40%. With varying degrees of assurance, nine resonances are identified with an increase in symmetry; five more regions of increased symmetry are associated with resonances or a background effect. Twenty resonances are identifed with a decrease in symmetry. In a sample containing 500 levels in the resonance region, there was no level with a Ag^{111} yield even one-thirtieth as great as Mo^{99}. It is thus very improbable that there are any neutron resonances in U^{235} that lead to predominantly symmetric fission.

8800 THE PHOTOFISSION OF Bi, Th AND U BETWEEN 300 AND 1000 MeV.
H.G.de Carvalho, A.Celano, G.Cortini, R.Rinzivillo and G.Ghigo.
Nuovo Cimento (Italy), Vol. 19, No. 1, 187-9 (Jan. 1, 1961).

Loaded emulsions were exposed perpendicular to the collimated γ-ray beam of the Frascati synchrotron. The results show a linear increase in yield as the maximum photon energy is increased from 300 to 1000 MeV. This indicates a constant cross-section. The cross-sections are compared with estimated values for photostar production and it is found that the ratio, i.e. the fissionability, is strongly dependent on the nucleus. A.Ashmore

8801 ANGULAR DISTRIBUTION OF PHOTOFISSION FRAGMENTS FROM URANIUM.
H.G.de Carvalho, A.G.da Silva and J.Goldemberg.
Nuovo Cimento (Italy), Vol. 19, No. 6, 1131-41 (March 16, 1961).

The angular distributions of photofission fragments from uranium at X-ray maximum energies of 6.9, 8.1, 9.4, 15.5 and 20 MeV were measured using a 24 MeV betatron. The anisotropy was found to increase with decreasing X-ray energy and to be mainly consistent with $a + b \sin^2 \theta$ electric dipole photon absorption distribution. The quadrupole contribution is shown to be small. The ratio of the anisotropic dipole absorption to the isotropic fission yields at the first three superior energies are 2.80 ± 0.44, 1.18 ± 0.14 and 0.62 ± 0.12. At 15.5 and 20 MeV the distributions are almost isotropic.

NUCLEAR POWER STUDIES

8802 NON-LINEAR STABILITY OF NUCLEAR REACTORS. H.B.Smets.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 57-65.

By analysis of the kinetic equations for periodic solutions it is shown that a reactor is absolutely stable for small perturbations if the cosine Fourier transform of the impulse response is everywhere positive. It is also shown that such a reactor is absolutely stable for large perturbations. W.G.Stripp

8803 SIGNAL-FLOW GRAPHS AND STABILITY ANALYSIS OF NUCLEAR REACTORS. A.B.van Rennes.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 67-74.

Signal flow graphs in the time and frequency domains are set up for a simple reactor, and from the frequency domain graph the transfer function N/Q for the response in neutron concentration to the excitation from a neutron source is derived. The method is then used to obtain the response to changes in the multiplication factor. W.G.Stripp

8804 NEW FORMS OF SOLUTION OF THE BOLTZMANN EQUATION FOR MONOENERGETIC NEUTRON TRANSPORT IN SPHERICAL GEOMETRY. W.Kofink.
Z. Phys. (Germany), Vol. 162, No. 5, 489-507 (1961). In German.

The singular solution of the Boltzmann equation for transport in spherical geometry is derived. The calculation is performed in two steps. First, a partial differential equation with an assumed density on its right-hand side is solved. But the partial solution found in this way will generally not yield the assumed density. Therefore one has to add a suitable solution of the homogeneous differential equation. This addition leads to an equation of compatibility which turns out to be a Sonine integral equation. The second step of the calculation is the solution of this integral equation. The total solution of the Boltzmann equation is written down in two different representations, but its uniqueness has been proved. The main singularity at the centre of the sphere is proportional to $1/(\rho\sqrt{1-\mu^2})$. A term $\log \rho$ does not appear, but a term proportional to $\log[(1+\mu)/(1-\mu)]$ does, which, however, loses its importance at the centre of the sphere $\rho = 0$ in comparison with the main singularity. A characteristic equation need not occur in this mathematical procedure; it may or may not be introduced. Therefore no hint at the spectrum of the Boltzmann operator in spherical geometry is given. It is shown that there exists a remarkably short integral representation of the regular solution, which satisfies from the first all requirements, if the validity of the characteristic equation is supposed. But there are also regular solutions, given by the difference of two singular solutions, which need not satisfy a characteristic equation. Both kinds of regular solutions in spherical geometry are given as superpositions of solutions in plane geometry which belong to the discrete or to the continuous spectrum of the Boltzmann operator. The regular solutions are identical with the corresponding well-known series of spherical harmonics, where the supposition of a characteristic equation need also not necessarily be made for exact solutions in the infinite space. A preliminary discussion of this problem is given.

8805 THE PRESENT OUTLOOK FOR CONTROLLED THERMONUCLEAR FUSION. G.Warfield.
RCA Rev. (USA), Vol. 22, No. 1, 122-30 (March, 1961).

Extensive effort has been expended in the last few years toward the development of controlled thermonuclear fusion based on the confinement of a very-high-temperature plasma. It is the opinion of the author that, barring a new approach, a useful power-producing fusion reactor is several decades away. In the immediate future, the concentration in fusion research will probably shift from a study of fusion itself to a study of basic plasma physics. Some of the reasons for this conclusion are discussed.

ATOMIC AND MOLECULAR PHYSICS

THE NEW UNIT OF ATOMIC MASS. See Abstr. 8035

ATOMS

8806 STATIONARY PROPERTIES OF THE HARTREE–FOCK APPROXIMATION. M.Cohen and A.Dalgarno.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 748-50 (March, 1961).

The theorem is proved that the first order correction to the expectation value of any operator which can be expressed as a sum of one-electron operators vanishes if Hartree–Fock wave functions are used in its evaluation.

CUBIC CRYSTAL FIELD SPLITTING OF THE Gd^{3+} ION. See Abstr. 7517

SPIN-POLARIZED HARTREE–FOCK CALCULATION ON Gd^{3+}. See Abstr. 7524

8807 THE 2^3S EXCITATION IN HELIUM. G.S.Higginson and L.W.Kerr.
Proc. Phys. Soc. (GB), Vol. 77, Pt 4, 866-8 (April, 1961).

A simple diffusion method was employed to measure the shape of the excitation probability curve above the threshold of the 2^3S excitation in helium. The results are in substantial agreement with those of Schulz and Fox (1957).

HYPERFINE STRUCTURE OF ARSENIC-76. See Abstr. 8566

EFFECTS OF DISTRIBUTED NUCLEAR MAGNETIZATION ON HYPERFINE STRUCTURE IN ODD A NUCLEI. See Abstr. 8547

8808 SIMULTANEOUS EFFECT OF DOPPLER AND FOREIGN GAS BROADENING ON SPECTRAL LINES. L.Galatry.
Phys. Rev. (USA), Vol. 122, No. 4, 1218-23 (May 15, 1961).

By using the classical Fourier integral theory, an expression is given for the shape of a spectral line, broadened by phase changes due to collisions and by the actual changes in velocity of the emitting particles resulting from collisions. The result is not a simple Voigt type folding of an exponential into a dispersion distribution; it exhibits the contraction noted by Dicke (Abstr. 2334 of 1953) and leads to the usual formulae when the time interval between path-deflecting or phase-disturbing collisions becomes very great.

8809 STARK BROADENING OF HYDROGENIC ION LINES IN A PLASMA. H.R.Griem and K.Y.Shen.
Phys. Rev. (USA), Vol. 122, No. 5, 1490-6 (June 1, 1961).

The frequency distributions of the ionized helium lines at 4686 and 3203 A broadened by the local fields of both ions and electrons in a plasma are calculated in the classical path approximation, which is shown to be always applicable. General formulae are developed for the Stark profiles of lines from multiply ionized hydrogenic systems, and the validity domains of the impact and quasi-static approximation for electron and ion broadening are delineated. The results are compared with the Holtsmark theory and an approximation for high series members.

8810 COHERENCE EFFECTS IN RESONANCE FLUORESCENCE. M.E.Rose and R.L.Carovillano.
Phys. Rev. (USA), Vol. 122, No. 4, 1185-94 (May 15, 1961).

The crossed-level method of atomic spectroscopy is discussed and the angular distribution formula for both the incoherent and coherent resonance scattering is derived. The form of this distribution function, as given here, explicitly displays the geometric factors depending on radiation propagation vectors. With the application to hydrogen in mind, the distribution function is expressed explicitly for single electron transitions with external fields possessing axial symmetry. The properties of the distribution function are discussed with emphasis on the case of unpolarized radiation. For the case of hydrogen there are two possible applications of major interest. The first concerns the possibility of a precision measurement of the 2p fine structure splitting and hence a determination of the fine structure constant. Explicit results for the shape and other properties of the resonance line with a uniform magnetic field obtained. The other application is concerned with the possibility of measuring the 2s–2p Lamb splitting. This requires an electric field parallel to the magnetic field. Unfortunately, the level crossings which are sensitive to the Lamb splitting cannot radiate sufficiently rapidly while those which do radiate appreciably occur at field strengths which are extremely insensitive to the Lamb splitting.

8811 FREQUENCY SHIFTS IN HYPERFINE SPLITTING OF ALKALIS: A CORRECTION. R.Herman and H.Margenau.
Phys. Rev. (USA), Vol. 122, No. 4, 1204-6 (May 15, 1961).

See Abstr. 12733 of 1959. The effect of the deformation of the wave-functions by Van der Waals interactions, previously ignored, upon the hyperfine shifts of alkalis caused by rare gas atoms is computed. It is found to be large and clearly in need of consideration. When applied to the experimentally observed shifts, the model

oposed earlier, with the new values of the interaction constants, ads to "interaction radii" somewhat greater than before and more arly equal to gas kinetic radii.

8812 ENERGY LEVELS AND MAGNETIC DIPOLE TRANSITIONS IN THE $4p^4$ GROUND CONFIGURATION OF INGLY IONIZED ATOMIC BROMINE (Br II).
.C.Martin and J.L.Tech.
Opt. Soc. Amer., Vol. 51, No. 6, 591-4 (June, 1961).

Improved values of the previously known Br II energy levels elative to the $4p^4\ ^3P_2$ ground level at 0.0 cm^{-1} were obtained from reliminary observations in the vacuum unltraviolet region. The osition of the $4p^4\ ^1S_0$ level was found from the "forbidden" transion, $4p^4\ ^3P_1 - 4p^4\ ^1S_0$ at 4042.42 A. An observation of the transverse eeman effect for this line yields a Lorentz triplet with the usual olarizations reversed and approximately the expected splitting. It thus confirmed that the line arises from magnetic dipole radiaon. A similar line at 8269.65 A, due to the transition $4p^4\ ^3P_2 - 4p^4\ ^1D_2$, shows hyperfine-structure broadening consistent with the alculated structure. New values for the levels of $4p^4$ are: $^3P_1$ = 3136.4 cm^{-1}, $^3P_0$ = 3837.5 cm^{-1}, $^1D_2$ = 12089.1 cm^{-1}, and $^1S_0$ = 27867.1 cm^{-1}. The values for all levels above $4p^4$, as given in tomic Energy Levels, Vol. II [Circ. Nat. Bur. Stand. (USA), No. 467 952)] should be reduced by 5.9 ± 0.5 cm^{-1}. Intermediate-coupling arameter values which yield a good fit for Br II $4p^4$ are $F_2(4p,4p)$ = 1690 cm^{-1} and $\zeta(4p)$ = 2800 cm^{-1}.

8813 THE SHIFT OF THE ABSORPTION LINES OF Fe I DUE TO THE PRESENCE OF HELIUM.
iang-Yi Ch'en and V.Chandrasekharan.
strophys. J. (USA), Vol. 133, No. 3, 1067-71 (May, 1961).

The shift of the absorption lines of neutral iron (λ 2510 to 3200) under 46 lb/in^2 of helium at 1347°C and under 950 lb/in^2 helium at 1290°C was observed using a 35 ft grating (1.6 A/mm). ll lines exhibited a "violet" shift. From the differences of the iifts of various fine-structure lines, the displacements of the arious energy levels relative to the common ground level a^5D were ound. Under 950 lb/in^2 of helium the displacements were 5:1.50:1.0 cm^{-1} for y^5P^0, y^5D^0, and y^5F^0, respectively. The levels ith high j-values showed a larger upward displacement. The violet iift of a number of impurity lines was also measured.

8814 WAVELENGTHS OF KRYPTON 86, MERCURY 198, AND CADMIUM 114. C.F.Bruce and R.M.Hill.
ustral. J. Phys., Vol. 14, No. 1, 64-88 (March, 1961).

The vacuum wavelengths and the spectral line profiles for four nes of Kr^{86}, four lines of Hg^{198} and four lines of Cd^{114} were measured. ne line, the radiation $2p_{10}$-$5d_5$ of Kr^{86} (6057 A), was used as the eference standard in the wavelength measurements. A variable gap abry–Perot interferometer with electromagnetically controlled late holders was used throughtout under vacuum conditions. The se of photoelectric recording methods and mechanical scanning ade it possible to compare wavelengths with an accuracy of better an 1 part in 10^8, and half-intensity widths of lines were measured ith an accuracy of 0.5 mK (0.0005 cm^{-1}). The 6057 A line of Kr^{86} as examined under different operating conditions of the Engelhardype lamp and small wavelength shifts due to variation of temperature, ressure, and current density were measured. The Doppler shift nd interatomic Stark shift annul each other if the lamp is viewed in ne direction cathode to anode to observer, and is operated in a quid air bath with the temperature near the capillary surface of the mp at 63 ± 1°K and with a current density of 0.28 ± 0.05 A/cm^2. he Doppler shift under these conditions was found to be 0.014 ± 0.003 m^{-1} (– 50 ± 10 μA) and the interatomic Stark shift 0.014 ± 0.003 m^{-1} (+ 50 ± 10 μA). Under these conditions also the alf-intensity width is 13.5 ± 0.5 mK, and the wavelength emitted is at for the unperturbed state of the atoms to 2-3 parts in 10^9. This ne is superior to the other lines examined for sharpness and eproducibility and other wavelengths may be established in terms f it to at least 1 part in 10^8. This is the line that has been ecommended as the new primary standard of length.

8815 OPTICAL CROSS SECTION OF RESONANCE LINES EMITTED BY FLAMES UNDER CONDITIONS OF ARTIAL THERMAL IONIZATION. F.W.Hofmann and H.Kohn.
Opt. Soc. Amer., Vol. 51, No. 5, 512-21 (May, 1961).

A method for determining optical cross-sections, based on nding the point of intersection of the low- and high-density asymptes of an intensity-density curve, is extended to elements of low onization potentials. These elements suffer partial thermal ionizaon in the flame gases at the relatively high temperatures of 2500 nd 2760°K which are used as spectroscopic light sources. Since the degree of ionization of the carrier atoms depends on their partial pressure, the intensity–density curves may be distorted. This difficulty is overcome by increasing the concentration of electrons in the flame gases and thereby shifting the ionization equilibrium to the side of neutral atoms. For the alkaline earth elements the existence of equilibrium ionization is tested for by direct, independent measurements of the partial pressures which enter into the Saha equilibrium quotient. Optical cross-sections are measured for the resonance lines of Li, Na, K, Rb, Cs, Ca, Sr, and Ba. The values for the alkalis exhibit a moderate increase with atomic weight which is in accordance with the Weisskopf–Lindholm theory of impact broadening.

8816 SPECTRAL STRUCTURE OF NEUTRAL AND IONIZED OSMIUM. A.M.Van Kleef and P.F.A.Klinkenberg.
Physica (Netherlands), Vol. 47, No. 1, 83-94 (Jan., 1961).

Results of an analysis of all data available on the Os I and Os II spectra are communicated. Of a total number of 263 Os I levels 155 could be interpreted in terms of the quantum theory. The ground level system is associated with the electron configurations $5d^66s^2$ and $5d^76s$, which are strongly intermingled. Of the $5d^8$- configuration, however, no trace has been found. In the odd system most levels could be assigned to multiplets of the configurations $5d^66s6p$, $5d^56s^26p$ and $5d^76p$. Many of the high even states have been attributed to the configurations $5d^66s7s$, $5d^56s^27s$ and $5d^66s6d$. The number of classified Os I lines is about 40% of the total number known. For the ionization potential of the Os-atom a value of (8.5 ± 0.1) V has been found. As regards Os II, the main progress in the analysis was the definite establishment of $5d^56s^2\ ^6S_{5/2}$ and the identification of $5d^56s(^7S)6p\ ^8P_{5/2,\ 7/2,\ 9/2}$. Approximately 15% of all known Os II lines above 2000 Å have been classified. Complete tables of energy levels of Os I and Os II with observed J- and g-values and quantum assignments are presented in this paper.

8817 GROUND STATE OF THE FIRST SPECTRUM OF PLUTONIUM (Pu I), FROM AN ANALYSIS OF ITS ATOMIC SPECTRUM. L.Bovey and S.Gerstenkorn.
J. Opt. Soc. Amer., Vol. 51, No. 5, 522-5 (May, 1961).

Data from King furnace work and hyperfine-structure and Zeeman studies on the spectra of Pu I have resulted in the derivation of three levels of the ^7F term. It is suggested that this term arises from the ground-state electronic congifuration $5f^6 7s^2$ and that these levels are at 0.0 cm^{-1} ($^7F_0$), 2203.6 cm^{-1} ($^7F_1$), and 4299.6 cm^{-1} ($^7F_2$).

H.F.S. SEPARATIONS AND ISOTOPE SHIFTS FOR $Tl^{199-202,\ 204}$
See Abstr. 8567

8818 NUCLEAR AND RELATIVISTIC EFFECTS IN ATOMIC SPECTRA. A.P.Stone.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 786-96 (March, 1961).

The electronic Hamiltonian for a general atom is obtained as far as terms in $1/c^2$ and m/M_A by reducing a relativistic wave equation with four components for each electron and nucleon to an approximately relativistic form with two components per particle. The presence of non-Hermitian terms in the reduced Hamiltonian is explained. Relativistic corrections to the Coulomb and nuclear interactions and the effect of the intrinsic magnetic moments are treated by first-order perturbation theory. The electronic Hamiltonian is obtained in the centre-of-mass system of the atom. The hyperfine structure interaction is obtained by expressing all electron–nucleon terms as multipole expansions, giving the previously known hyperfine structure expansion with recoil corrections. The exact operator for the nuclear field effect in isotope shift is obtained from the Coulomb interaction. The presence of other corrections depending on nuclear structure is indicated. Terms referring only to s electrons are not considered as the reduction procedure used does not cover the contact approach of particles (cf. Ma 1956). The usual calculation of the normal mass effect in isotope shift is investigated for non-s-electron configurations and is shown to be justified if 0.1% of the spin–orbit interaction and the whole of the other relativistic perturbations are negligible in comparison with the term value.

8819 NUCLEAR EFFECTS OBSERVED IN X-RAY SPECTRA. J.J.Merrill and J.W.M.DuMond.
Nuclear structure conference, Kingston, Ontario, 1960 (see Abstr. 2153 of 1961) p. 637-9.

Measurements of the L X-ray spectra of heavy elements, W, Pt, Bi, Th, U, Np, Pu, and Am, with a precision two-crystal spectrometer are described. The possibility of detecting a nuclear size effect on the L_{II}–L_{III} fine-structure splitting is discussed, and

the increased widths of some lines for high atomic number are explained. First experimental evidence for an X-ray hyperfine structure line broadening attributed to the large nuclear magnetic moment of Np^{237} is presented.

8820 X-RAY CONTINUA AND LINE SPECTRA FROM HIGHLY STRIPPED ATOMS IN A MAGNETICALLY COMPRESSED PLASMA.
A.J.Bearden, F.L.Ribe, G.A.Sawyer and T.F.Stratton.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 257-60 (March 15, 1961).

The authors studied the line spectra of discharges of deuterium and of deuterium + 10% neon. The line spectra of the deuterium discharge consisted of the hydrogen-like spectrum of O VIII and the helium-like spectra of Na X, Mg XI, Al XII and Si XIII. The impurities arose from the discharge-tube walls. In the discharge of deuterium + 10% neon, lines of Ne IX and Ne X appeared prominently. From a study of the energy distribution of the continuum, electron temperatures of 345 ± 40 eV and 295 ± 30 eV were assigned to discharges of deuterium and deuterium + 6% O_2. The measurements were made in the Scylla experiment (Abstr. 13385 of 1960).
M.S.Sodha

8821 OPTICALLY DRIVEN SPIN PRECESSION.
W.E.Bell and A.L.Bloom.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 280-1 (March 15, 1961).

The observation of induced spin polarization by light, modulated at the resonance frequency, is reported. Circularly polarized resonance radiation passes through an alkali vapour cell placed in a magnetic field. The effect is observed as a change in the light intensity. Observations are made for Cs, Rb and He at respectively 0.175, 0.350 and 1.4 Mc/s.
F.Bruin

THE DIFFUSION OF RESONANCE EXCITATION THROUGH A GAS. See Abstr. 8086

8822 APPLICATION OF THE IMPULSE APPROXIMATION TO THE SCATTERING OF ELECTRONS BY ATOMS. I. INELASTIC SCATTERING BY HYDROGEN ATOMS.
R.Akerib and S.Borowitz.
Phys. Rev. (USA), Vol. 122, No. 4, 1177-84 (May 15, 1961).

A calculation of the ionization cross-section and the excitation cross-section to the 2S and 2P states of hydrogen atoms by collision with electrons is carried out using an impulse approximation. The results are compared to the experimental data and to various other theoretical calculations. The cross-sections obtained compare favourably with experiment. The calculations carried out by these methods are no more complicated than the usual approximation methods and are easily adaptable for use with more complicated atoms.

8823 APPLICATION OF THE SCHWINGER VARIATIONAL METHOD TO ZERO-ENERGY ELECTRON–HYDROGEN SCATTERING. H.E.Saraph.
Proc. Phys. Soc. (GB), Vol. 77, Pt 4, 827-9 (April, 1961).

The problem is formulated in terms of the radial exchange equations. The Schwinger method, with polynomial trial functions, is used to calculate the scattering length. With 3-term polynomials one obtains $\Lambda^+ = -9.72$, $\Lambda^- = -2.35$ compared with $\Lambda^+ = -8.095$, $\Lambda^- = -2.350$ from exact numerical integrations.

THEORY OF PRIMARY SPECIFIC IONIZATION IN HELIUM. See Abstr. 8305

8824 ELECTRON COLLISIONS WITH Na ATOMS.
A.Salmona and M.J.Seaton.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 617-29 (March, 1961).

Gives results of calculations for energies above the 3p excitation threshold and also for the limit of zero kinetic energy. For the higher energies the Bethe approximation is used to calculate partial wave integrals and the transmission matrix is then obtained by two different methods, both of which ensure that conservation conditions are satisfied exactly (Abstr. 454, 3506 of 1961). The only potential considered is V(3s, 3p). For energies not too close to the 3p threshold these calculations give good results for the 3s–3p cross-section and fairly good results for the total cross-section. This shows that a substantial part of the elastic scattering is due to the process 3s→3p→3s. At very low energies exchange effects and polarization effects are both large and a much more elaborate theory is required. The coupled integro–differential equations, of Hartree–Fock type, are discussed in detail. It is shown that the coupling between 3s and 3p accounts for 99.4% of the atom polarizability. Solutions of the coupled equations for 3s and 3p are obtained for the case of zero kinetic energy. The calculated zero-energy elastic cross-section is $380\pi\alpha^2_0$ and the exchange cross-section is $440\pi\alpha_0^2$. These calculated values are consistent with those obtained experimentally.

8825 SCATTERING OF HIGH-VELOCITY NEUTRAL PARTICLES. XI. FURTHER STUDY OF THE He–He POTENTIAL. I.Amdur, J.E.Jordan and S.O.Colgate.
J. chem. Phys. (USA), Vol.34, No. 5, 1525-30 (May, 1961).

For Pt X, see Abstr. 8742 of 1957. Results are presented for two studies of the scattering by room-temperature helium of beams of helium atoms with controlled energies in the approximate range 150-1500 eV. The interaction potential derived from the two sets of measurements is represented by

$$\phi(r) = 5.56 \times 10^{-12}/r^{5.03} \text{ erg} \qquad (0.97 \text{ A} < r < 1.48 \text{ A}).$$

Where there are common ranges of the interaction distance r this potential is in reasonable agreement with He–He potentials previously determined from scattering experiments. In its specified range of validity, it is somewhat lower than most of the corresponding values calculated quantum mechanically.

8826 INELASTIC SCATTERING OF ATOMS. I. INTERMULTIPLET TRANSITIONS. W.R.Thorson.
J. chem. Phys. (USA), Vol. 34, No. 5, 1744-57 (May, 1961).

Electronic-translational energy transfer processes have minute cross-sections for atoms with thermally attainable kinetic energies unless the amount of energy converted from electronic to translational form (or vice versa if the threshold permits) is rather less than 1 eV. The transfer processes of interest to chemical kinetics, therefore, involve highly restricted sets of energy levels. Two situations are commonly encountered: (1) The "two-state" case, in which two energy levels of the diatomic system cross or approach closely in energy, so that a respectable probability of resonance transfer is achieved; cases of this type almost always involve transfer of most of the excitation from one atom to the other. (2) Transitions among the multiplet levels of a given Russell–Saunders term of an atom, induced by collision with an "inert" atom. Spin–orbit coupling is the electronic interaction splitting the levels. The present work is concerned with the latter case. The "high-energy approximation", a necessary modification of the Born approximation and various "modified adiabatic approximations", which take account of the details of angular momentum coupling during collision, are described, and practical methods of calculation considered.

CONDENSATION OF ATOMIC AND MOLECULAR HYDROGEN AT LOW TEMPERATURES. See Abstr. 8838

8827 CALCULATION OF THE DIAMAGNETIC COEFFICIENT OF FREE ATOMS. C.Courty.
J. Phys. Radium (France), Vol. 21, No. 4, 233-41 (April, 1960). In French.

Starting from first ionization energies of atoms, a screening effect is determined, which is then corrected for the experimental "screen jumps". This corrected screen effect enables the diamagnetic mass susceptibility of free atoms to be computed without modification of the principal quantum numbers. The method suggests the possibility of the same calculation for combined atoms and for molecules.

MOLECULES

8828 COUPLED ANHARMONIC VIBRATIONS AND SPECTRAL BAND BROADENING. R.S.McDowell.
J. chem. Phys. (USA), Vol. 34, No. 3, 1065 (March, 1961).

Two errors in Frisch and Vidale's calculation (Abstr. 2476 of 1957) are corrected. This leads to an estimated bandwidth of 136 cm^{-1}. This is in better agreement with experimental bandwidths of hydrogen bonded compounds than the original calculation. Quantitative application to particular systems are not expected to be satisfactory for two reasons: (1) the classical model assumed for the system is obviously invalid and (2) there are great difficulties in evaluating the anharmonicity force constant α.
T.E.Peacock

8829 K-TYPE RESONANCE AND DOUBLING IN AXIALLY SYMMETRIC MOLECULES. G.Amat and L.Henry.
J. Phys. Radium (France), Vol. 21, No. 10, 728-30 (Oct., 1960). In French.

It is established that, in the case of axially symmetric mole-

ıles, the second order transformed rotation—vibration Hamiltonian ıs nonvanishing matrix elements of the form $(K|h'_{21}|K \pm n)$ where = 3 or 4 for molecules of 3- and 4-fold axial symmetry respecti-ely. The corresponding effect is called K-type resonance or f n = 4; K = ∓ 2) K-type doubling. The coefficients of the matrix ements were calculated as functions of the molecular constants r the different symmetry groups.

8830 EVALUATION OF $\omega_e x_e$ FROM THREE CONSTANT POTENTIAL ENERGY FUNCTIONS.
.P.Varshni and R.C.Shukla.
rans Faraday Soc. (GB), Vol. 57, Pt 4, 537-45 (April, 1961).

It was shown earlier (Abstr. 3408 of 1958) that $\omega_e x_e$ can be xpressed in terms of $U'''(r_e)$, $U^{iv}(r_e)$ and other experimental uantities. $U'''(r_e)$ and $U^{iv}(r_e)$ are determined from potential nergy functions. Such a procedure leads to $\omega_e x_e$ as a function of $\Delta(= k_e r_e^2/2D_e)$ (called method I). Here an alternative procedure s proposed. $U^{iv}(r_e)$ is obtained from the potential energy function, ut $U'''(r_e)$ is determined from the experimental constants. Con-equently $\omega_e x_e$ can now be expressed as a function of Γ and Δ, here $\Gamma = [1 + \alpha_e\omega_e/6B_e^2]^2$ (denoted by method II). Percentage rrors by method II, for most of the molecules examined, are igher than those by method I. An empirical expression for $\omega_e x_e$ as been suggested:

$$\omega_e x_e = \left[a + b\left(\frac{\Delta}{\Gamma}\right)^{1/2} + c\left(\frac{\Delta}{\Gamma}\right)\right]\frac{W\Gamma}{\mu_A r_e^2}$$

here a, b and c are constants. Results by this expression are uite satisfactory. This and other studies indicate that the experi-ıental value of $\omega_e x_e$ for the ground state of Cl_2 may be in error. ymbols: ω_e, vibration frequency; $\omega_e x_e$, vibrational constant; e rotational constant; k_e, force constant; r_e, equilibrium inter-uclear distance; D_e, dissociation energy. Sutherland parameter , $= k_e r_e^2/2D_e$; $\Gamma = [1 + (\alpha_e\omega_e/6B_e^2)]^2$.

8831 MEASUREMENT OF WEAK ABSORPTION BY MOLECULES. O.Oldenberg, D.G.Bills and N.P.Carleton.
. Opt. Soc. Amer., Vol. 51, No. 5, 526-30 (May, 1961).

To measure small concentrations of molecules, particularly in metastable state, a form of double-beam absorption spectrometer as developed. This instrument allows the use as an absorber of a ıbe in which a d.c. discharge creates unstable species. The design covides that light emitted from this discharge shall not interfere ith the absorption measurement. A second discharge tube is used ; a background source to emit the band system whose absorption to be observed. The absorption of a single vibrational band of ıown probability of transition is measured. A detailed analysis of ıe relative intensities of all the lines constituting the band is then ecessary in order to extract the population of the metastable level.

SIMULTANEOUS EFFECT OF DOPPLER AND FOREIGN AS BROADENING ON SPECTRAL LINES. See Abstr. 8808

8832 MICROWAVE SPECTRUM OF ISOBUTYLENE. DIPOLE MOMENT, INTERNAL BARRIER, EQUILIBRIUM)NFORMATION, AND STRUCTURE. V.W.Laurie,
chem. Phys. (USA), Vol. 34, No. 5, 1516-19 (May, 1961).

The microwave spectra of isobutylene and isobutylene d-3 re studied in the region 17-36 kMc/s. Observed rotational nstants (Mc/s) for isobutylene are $a_0 = 9133.32$, $b_0 = 8381.75$, = 4615.99; for sym-isobutylene d-3, $a_0 = 9132.59$, $b_0 = 7788.98$, = 4431.05; for asym-isobutylene d-3, $a_0 = 8819.46$, $b_0 = 7981.08$, = 4469.59. The most likely structure compatible with these ta is $r_{C-C} = 1.50_7$ A, $r_{C=C} = 1.34$ A, r_{CH}(methyl) $= 1.08_5$ A, $_H$(ethylenic) $= 1.08_6$ A, $<$ Me−C−Me $= 115.9^0$, $<$ HCH(methyl) $= 108^0$, HCH(ethylenic) $= 117.5^0$. Measurements of the Stark effect show at the dipole moment $\mu = 0.503 \pm 0.009$ D. Fine structure leads a barrier height hindering internal rotation of the methyl groups 2.21 kcal/mole. The equilibrium conformation is C_{2v} with two ethyl hydrogens in the plane of the carbon atoms and the CH bonds inting away from the symmetry axis. It is concluded that hough CC single bonds are shortened when adjacent to a double nd, the double bond length is probably not much affected by the esence of an adjacent CH_3 group.

8833 MILLIMETRE WAVE SPECTRUM AND DIPOLE MOMENT OF VINYL FLUORIDE.
.M.Mirri, A.Guarnieri and P.Favero.
uovo Cimento (Italy), Vol. 19, No. 6, 1189-94 (March 16, 1961).

By analysing the spectrum of a vinyl fluoride in the range om 100 to 160 Gc/s its rotational constant A was determined and found to be 64 582.7 Mc/s. The centrifugal distortion constants are also given. Measurements of the Stark effect on four low J "a" type transitions give the value $\mu = (1.42_7 \pm 0.010)$d for the total dipole moment.

8834 MICROWAVE SPECTRUM OF CIS-1,2-DICHLOROETHYLENE. T.Shimizu and H.Takuma.
J. Phys. Soc. Japan, Vol. 15, No. 4, 646-50 (April, 1960).

The spectrum was observed in the frequency range 20—25 kMc/s. The determined molecular parameters, $d_{CCL} = 1.724$ A and $\angle CCCl = 121^0 33'$ on the assumption of $d_{CC} = 1.32$ A, $d_{CH} = 1.07$ A and $\angle CCH = 120^0$, show good agreement with the parameters of vinylidene chloride, which was studied previously by the authors. The quadrupole hyperfine coupling constants were found to be $eQq_{aa} = 2$ Mc/s, $eQq_{bb} = -22$ Mc/s and $eQq_{cc} = 20$ Mc/s.

8835 THE ROTATIONAL STRUCTURE OF THE FUNDAMENTAL INFRARED BANDS OF METHANE-TYPE MOLECULES. J.Herranz.
J. molecular Spectrosc. (USA), Vol. 6, No. 3, 343-59 (March, 1961).

The vibrational—rotational Hamiltonian function for tetrahedrally symmetric pentatomic molecules is obtained to a second-order approximation. In this approximation, the fundamental bands ν_3 and ν_4 of the absorption spectrum are studied. The general expressions for the rotational frequencies are

$$\nu_{I(J,\tau)} = U_I(J) + V_I(J)(J,\tau|\,S\,|J,\tau),$$

where I designates one of the branches P, Q, or R of the band; U_I and V_I are functions of the rotational quantum number J; τ is an index which has $2J + 1$ values;

$$S = P_x^4 + P_y^4 + P_z^4 - 3(P_x^2 + P_y^2 + P_z^2)^2/5 + (P_x^2 + P_y^2 + P_z^2)/5,$$

where P_x, P_y, and P_z are the components of the total angular momentum; and $(J,\tau|S|J,\tau)$ is the (J,τ)th element of the diagonal matrix representation of S. Expressions for $U_I(J)$ and the numerical values of $(J,\tau|\,S\,|J,\tau)$, for J up to 16, are given.

8836 INFRARED SPECTRA OF METHANOL AND DEUTERATED METHANOLS IN GAS, LIQUID, AND SOLID PHASES. M.Falk and E.Whalley.
J. chem. Phys. (USA), Vol. 34, No. 5, 1554-68 (May, 1961).

The infrared spectra of CH_3OH, CH_3OD, CD_3OH, and CD_3OD in the five phases gas, liquid, vitreous solid, α-crystal, and (except perhaps for CD_3OH and CD_3OD for which the solid—solid transitions were studied) β-crystal were recorded in the range 4000 to 300 cm^{-1}. The Raman spectrum of liquid CD_3OH was also recorded. A complete assignment of the internal modes is given, which differs somewhat from previous assignments for the CH_3 bending and rocking vibrations. No significant difference in spectrum occurred between the α-crystal and β-crystal phases. Under the full symmetry of the β-phase determined by X-ray diffraction only one OH out-of-plane bending band should occur. Two bands are observed, and it is concluded that the carbon and oxygen atoms in one chain are not coplanar, as is required by the symmetry determined by X-ray diffraction (Tauer and Lipscomb, Abstr. 9199 of 1952), but that the chains are puckered and the X-ray symmetry arises because the puckered chains are irregularly distributed, a structure that had been previously suggested by Tauer and Lipscomb tentatively on the basis of high apparent thermal amplitudes. Bands occur in the crystal spectra near 500 cm^{-1} and 340 cm^{-1} at -180^0 C. These are interpreted as lattice modes, probably the two infrared-active modes that involve translations of the molecules.

8837 DIFFERENCE OF INTERMOLECULAR POTENTIALS OF CH_3OH AND CH_3OD. E.Whalley and M.Falk.
J. chem. Phys. (USA), Vol. 34, No. 5, 1569-71 (May, 1961).

The intermolecular potentials of CH_3OH and CH_3OD are examined using the difference of the heats of vaporization at 0^0 K obtained from thermal data, and the vibrational frequencies obtained from the preceding abstract. They do not differ within the accuracy of the measurements. The intermolecular potential due to the change of the intramolecular zero-point energy is greater for CH_3OH than for CH_3OD, and so the other contributions to the intermolecular potential, namely repulsive, dispersion, electrostatic, etc., energies, are greater by $459 \pm \sim 260$ joule $mole^{-1}$ for the deuterium bond than for the hydrogen bond. This might be due mainly to a higher polarity of CH_3OD than of CH_3OH.

8838 CONDENSATION OF ATOMIC AND MOLECULAR HYDROGEN AT LOW TEMPERATURES.
R.T.Brackmann and W.L.Fite.
J. chem. Phys. (USA), Vol. 34, No. 5, 1572-9 (May, 1961).

With the use of reflected modulated atomic-beam techniques,

the reflection of hydrogen atoms and molecules at cold surfaces was examined. It was found that at low temperatures (~4°K) hydrogen atoms reflect as atoms with a very high probability. The reflection of hydrogen molecules is strongly dependent upon the amount of water vapour condensed on the target previously to or simultaneously with the H_2. The fact that condensation of stable gases can be affected by simultaneous condensation of water vapour at temperatures exceeding the gases' normal boiling point leads to an application in the form of an inexpensive way of producing vacua in the 10^{-5} mm Hg range.

8839 INFRARED AND RAMAN SPECTRA OF FLUORINATED ETHANES. XIV. $CF_2Cl-CHF_2$ AND $CF_2Br-CHF_2$.
P.Klaboe and J.R.Nielsen.
J. chem. Phys. (USA), Vol. 34, No. 5, 1819-26 (May, 1961).

For Pt XIII, see Abstr. 3540 of 1961. The infrared absorption spectra of gaseous $CF_2Cl-CHF_2$ and $CF_2Br-CHF_2$ at five temperatures between 30° and 180°C were obtained in the region 300-6000 cm^{-1} with a double-pass spectrometer equipped with CsBr, NaCl, and LiF prisms. In addition, infrared spectra of the solids at −170°C were recorded in the region 350–5000 cm^{-1}. The Raman spectra of the liquids at 30°, −30°, and −80°C were photographed with a three-prism glass spectrograph of reciprocal linear dispersion 15 A/mm at 4358 A, and polarization measurements were made. In all three states of aggregation both compounds exist as mixtures of rotational isomers. For each compound, the two isomeric forms (trans and gauche) are about equally stable, both in the gaseous and the liquid state. Tentative assignments are made of the fundamentals of both compounds.

8840 THE EMISSION BAND SYSTEM OF IODINE IN THE BLUE VIOLET. P.B.V.Haranath and T.A.Prasada Rao.
Indian J. Phys., Vol. 34, No. 3, 123-30 (March, 1960).

The discrete band system of iodine molecules was found to be more extensively developed when the spectrum was excited in a condensed discharge from a high tension transformer. About 150 bands were newly classified as forming part of the previously known discrete band system for which Waser and Wieland (Abstr. 571 of 1948) suggested the vibrational quantum formula.

8841 ON THE THEORY OF RAMAN INTENSITIES. A.C.Albrecht.
J. chem. Phys. (USA), Vol. 34, No. 5, 1476-84 (May, 1961).

The Herzberg–Teller development for vibronic transition moments is introduced into the Kramers–Heisenberg dispersion equation. It is shown how "forbidden" character (vibrationally induced intensity) in allowed electronic transitions is reponsible for the Raman intensities of fundamentals. This suggests a direct link between certain vibronic spectroscopic observations and Raman intensities. The development is carried on to the first order in nuclear displacements only — the higher terms give rise to Raman intensities of combinations and overtones. An equation for the polarizability components is obtained which leads directly to the Raman selection rules and in addition provides interesting predictions concerning the Raman and the resonance Raman effect in relation to excited electronic states. Rules are worked out governing the participication of excited electronic states in the Raman effect and these are employed to demonstrate a separability of σ and π contributions to the scattering of totally symmetric modes. The polarizability expression obtained here is compared with that of the semiclassical theory of Shorygin and an interesting resemblance is found. Finally it is shown how, depending on details of the electronic structure, the predicted form of the frequency dependence of scattered intensity ranges between the two expressions that have been commonly used to interpret observations.

8842 EFFECT OF MOLECULAR OXYGEN ON THE EMISSION SPECTRA OF ATOMIC OXYGEN–ACETYLENE FLAMES. S.L.N.G.Krishnamachari and H.P.Broida.
J. chem. Phys. (USA), Vol. 34, No. 5, 1709-11 (May, 1961).

Studies were made of the emission spectra (3000 to 6000 A) obtained from low-pressure atomic oxygen–acetylene flames diluted with varying amounts of molecular oxygen and molecular nitrogen. Added molecular oxygen greatly increased the OH emission while reducing CH and C_2 emission. It also had an effect on the rotational intensity distribution of OH and on the vibrational intensity distribution of C_2. Nitrogen addition greatly reduced the rotational and vibrational "temperatures" and decreased C_2 emission relative to the other emitters.

8843 ANALYSIS OF THE NAPHTHALENE VAPOUR ABSORPTION BANDS AT 3200 A. I. NAPHTHALENE h-8. D.P.Craig, J.M.Hollas, M.F.Redies and S.C.Wait, Jr.
Phil. Trans A (GB), Vol. 253, No. 1035, 543-68 (1961).

The absorption bands of vapour were measured at medium and high resolution and analyzed. The bands have strong heads weakly degraded to the red, The direction of polarization of the 0–0 pure electronic transition was identified from the band contour of the corresponding band, which shows a single intense maximum. Calculations of rotational energy levels confirm that this is a quasi-parallel A-type band of the asymmetric rotor, with polarization along the longer in-plane molecular axis. Accompanying the electronically allowed band is a set of stronger vibrationally induced bands, which show doubled intensity maxima. From approximate calculations of contours it is confirmed that these are quasi-perpendicular B-type bands, polarized along the shorter in-plane axis. The electronic assignment $B_{2u} \leftarrow A_g$, long-axis polarized, agrees with McClure's assignment (1956) from the spectrum of naphthalene embedded in durene crystals. The use of rotational band contours for assigning transitions is novel in larger molecules. A hitherto unrecorded ground-state frequency 506 cm^{-1} of species b_{3g} has been identified, and a number of other ground and excited-state frequencies confirmed and assigned, or recroded for the first time.

8844 ANALYSIS OF THE NAPHTHALENE VAPOUR ABSORPTION BANDS AT 3200 A. II. NAPHTHALENE d-8. D.P.Craig and J.M.Hollas.
Phil. Trans A (GB), Vol. 253, No. 1035, 569-83 (1961).

The absorption spectrum of octadeuteronaphthalene near 3200 A was measured and partially analyzed. The origin is at 32138.2 cm^{-1}, 118 cm^{-1} higher than that of naphthalene h-8. The analysis of the spectrum shows a nearly complete similarity to naphthalene h-8, with differences only in the relative ability of non-totally symmetrical vibrations of induce absorption along the shorter in-plane molecular axis. In naphthalene this ability is largely confined to two b_{3g} vibrations of 438 cm^{-1} and 911 cm^{-1} in the upper state; in naphthalene d-8, the b_{3g} vibration of 422 cm^{-1} behaves analogously to 438 cm^{-1} and induces the strongest bands in the system, but there are several higher b_{3g} frequencies giving false origins, indicating important changes in the vibrational modes on deuteration. As in naphthalene, long-axis polarized bands show single maxima and short-axis polarized bands two maxima spaced by 2 to 3 cm^{-1}. The band group with principal head 490 cm^{-1} below the origin shows a structure unique in the whole system: it is proposed that this is due to Coriolis coupling of the a_g fundamental 493 cm^{-1} to a newly identified b_{3g} fundamental 490 cm^{-1}. Several upper-state fundamentals are reported for the first time.

8845 THE 1600 A BAND SYSTEM OF AMMONIA. A.E.Douglas and J.M.Hollas.
Canad. J. Phys., Vol. 39, No. 4, 479-501 (April, 1961).

The progression of ammonia bands which extends from 1689 to 1400 A was photographed in absorption at high resolution. Six bands were analysed and found to be of the perpendicular type. The analysis shows that the molecule is planar in the excited state and that vibrational levels observed in the progression are those of the out-of-plane vibration. The excited electronic state is of the E'' type. In addition to the normal Coriolis interaction of the degenerate levels, a second effect has been observed which behaves like the Coriolis interaction recently described as "giant l-type doubling" by Garing, Nielsen, and Rao. No clear evidence has been found for any distortion of the degenerate state from D_{3h} symmetry.

8846 VACUUM ULTRAVIOLET ABSORPTION SPECTRA OF HEXAFLUOROACETONE AND HEXACHLOROACETONE S.R.La Paglia and A.B.F.Duncan.
J. chem. Phys. (USA), Vol. 34, No. 1, 350 (Jan., 1961).

Observations from 600 to 2150 A show that $(CF_3)_2CO$ has strong continuous absorption below 1050 A, suggesting an ionization potential around 95 000 cm^{-1}, and weaker absorption with a long-wave limit at 65 000 cm^{-1}. $(CCl_3)_2CO$ absorbs below 1500 A. Results are important for understanding molecular orbitals of the carbonyl group. A.G.Gaydon

8847 CORE POLARIZATION IN Li_2. O.Sinanoğlu and E.M.Mortensen.
J. chem. Phys. (USA), Vol. 34, No. 3, 1078-9 (March, 1961).

Using Callaway's potential (Abstr. 7250 of 1957) to represent the effect of the polarized Li^+ core, calculations were made of the correlation energy between the outer electrons and the cores in Li and in Li_2, both SCF and orthogonalized AO forms being used for the

er electrons. The binding energy was found to be little changed the inclusion of this energy, the atomic and molecular results rly cancelling. The core polarization was rather insensitive to crudeness of the orbitals used. J.Hawgood

8848 APPLICATION OF LIGAND FIELD THEORY TO THE ELECTRONIC SPECTRA OF GASEOUS $CuCl_2$, $NiCl_2$, D $CoCl_2$. J.T.Hougen, G.E.Leroi and T.C.James.
hem. Phys. (USA), Vol. 34, No. 5, 1670-7 (May, 1961).

The absorption spectra of $CuCl_2$, $NiCl_2$, and $CoCl_2$ in the gas se at 1000°C were obtained under low resolution in the visible, r infrared, and near ultraviolet regions. The observed absorptions e extinction coefficients of the order of 100 litre mole·cm, gesting that they correspond to "forbidden" intraconfigurational $\rightarrow d^n$ transitions analogous to those found in solutions and stals containing these metal ions. The observed spectra are rather l described by the two ligand field parameters appropriate to a lecule of symmetry $D_{\infty h}$.

8849 USE OF GAUSSIAN ORBITALS FOR ATOMS-IN-MOLECULE CALCULATIONS. M.Krauss.
chem. Phys. (USA), Vol. 34, No. 2, 692-3 (Feb., 1961).

Three calculations for H_2 are reported. The method formulated Hurley (Abstr. 1446 of 1956) is used. In the present calculation, Slater orbitals are replaced by Gaussian orbitals. Three trial ve functions are used and the results for equilibrium separation e compared with Hurley's calculation. The present work is found give results inferior to Hurley's work. However, the comparative se with which these calculations can be carried through makes ther work on larger molecules worthwhile. T.E.Peacock

8850 EXTRAORDINARY BASIC FUNCTIONS IN VALENCE THEORY. L.C.Snyder and R.G.Parr.
chem. Phys. (USA), Vol. 34, No. 5, 1661-5 (May, 1961).

It is pointed out that, provided kinetic energies are properly mputed, one may use functions which are continuous with piece-se continuous first derivatives as trial variation functions in antum-mechanical calculations of molecular electronic wave-nctions. As a simple example, a function of the type

$$A \exp[-(Z_< r_< + Z_> r_>)]$$

shown to be a good alternative to the conventional Eckart function r the helium atom. A rather more detailed study of helium is rried out to illustrate the use of individual lobes of real hydrogen-e atomic orbitals as an extended basic set of functions for olecular calculation. Implications for the general problem of rrelation energies in atoms and molecules are discussed, and it shown that a rationalization of the lowered electronic repulsions nployed in modern pi-electron theory is provided by the supposition at pi electrons tend to move in opposite rather than the same lobes pi orbitals.

8851 THE BINDING ENERGY OF THE σ BOND. I. GENERAL THEORY. K.O-ohata.
Phys. Soc. Japan, Vol. 15, No. 6, 1048-56 (June, 1960).

In the calculation it is necessary to take full account of the rlap integrals between bonded orbitals, but it is sufficient to e up to the second order terms for the overlap integrals between -bonded orbitals into account, because the magnitude of the latter rlap integrals is much smaller than that of the former integrals. e binding energy of a σ bond in the above approximation is cussed.

8852 POLARITY OF THE C–H BONDS IN ACETYLENE AND ITS MOLECULAR QUADRUPOLE MOMENT.
Hamano.
chem. Phys. (USA), Vol. 34, No. 5, 1678-83 (May, 1961).

By using the molecular quadrupole moment data of acetylene, polarity and the dipole moment of the CH bonds are investigated. e semiempirical LCBP MO method is applied to this problem. e results obtained show that the CH bonds in this molecule are ost homopolar, but hydrogen is slightly positive in polarity. om this, the so-called bond moment and the infrared bond ment and the infrared bond moment are discussed. The sign of molecular quadrupole moment of acetylene which cannot be en by the experimental data was determined as positive.

8853 THEORY OF LOCALIZED CONTRIBUTIONS TO THE CHEMICAL SHIFT. APPLICATION TO FLUOROBENZENES. M.Karplus and T.P.Das.
J. chem. Phys. (USA), Vol. 34, No. 5, 1683-92 (May, 1961).

An expression for the magnetic shielding tensor is obtained by the use of single-determinant Hartree–Fock molecular wave-functions. For nuclei of atoms in which the change in the second-order (paramagnetic) contribution is dominant, LCAO theory is employed to express the shielding in terms of localized bond parameters (ionic character, hybridization, and double bonding) and to compare it with the related treatments of the quadrupole coupling constant. Application of the formulation to the multifluorobenzenes provides an explanation of the available experimental chemical shift data and permits the prediction of shift values for other compounds. Of particular interest is the demonstration that double bonding in the C–F bond plays an important role in the fluorobenzenes. Also, the presence of an "ortho" effect in the shift is isolated by a comparison of experimental and theoretical results and tentatively explained in terms of charge repulsions.

8854 MOLECULAR MODEL OF THE HEISENBERG EXCHANGE INTERACTION. R.K.Nesbet.
Phys. Rev. (USA), Vol. 122, No. 5, 1497-1508 (June 1, 1961).

The electronic wave-function of N_2 is calculated for a series of internuclear distances, in the simplest LCAO approximation, including the principal effects of configuration interaction. As the internuclear distance increases there is a well-defined sequence of regions in which the ground state is most closely approximated by configurations in which successively more orbitals are represented as localized functions (definitely associated with one of the two atoms) rather than as the odd or even linear combinations of these appropriate to the full molecular symmetry. This corresponds to a continuous change in the nature of the unrestricted Hartree–Fock valence orbitals from molecular to atomic character as the atoms are separated. In the intermediate range of internuclear separation, it is a better approximation to treat some of the valence orbitals as modified atomic orbitals, coupled by an antiferromagnetic Heisenberg exchange interaction, than as molecular orbitals. Various contributions to the Heisenberg "exchange integral", of the kinds considered for the transition metals, are evaluated and compared. It is found that the ordinary direct exchange (which leads to ferromagnetic coupling) is small compared with the sum of the various antiferromagnetic effects, none of which can be described within the traditional Hartree–Fock approximation, which for solids becomes the energy band theory. A method is proposed by which the magnetic interaction in solids could be evaluated quantitatively, by modifying the usual energy band calculations in the same way that the usual molecular orbital theory is modified in the present work. Similar refinements to the band theory of the transition metals have recently been proposed by Goodenough on empirical grounds.

8855 NUCLEAR RELAXATION PROCESSES OF A NON-EQUIVALENT TWO-SPIN SYSTEM.
H.Shimizu and S.Fujiwara.
J. chem. Phys. (USA), Vol. 34, No. 5, 1501-11 (May, 1961).

Nuclear magnetic relaxation of a two-spin system is discussed using Redfield's semiclassical formulation of the relaxation processes. Time dependences of longitudinal magnetizations are given as a function of the ratio $J/\delta\nu_0$. An expression for the nuclear induction signal is given, from which the expected shape of multiplet lines and their behaviours upon saturation under various origins of the relaxation are discussed in detail. The discussion leads to the conclusion that the mechanism of nuclear relaxation can be determined by carefully analysing the spin multiplet lines on the basis of the theory. Finally, it is shown that there is a possibility of finding the absolute sign of the spin–spin coupling constant in a two-spin system using the multiple resonance method.

8856 TEMPERATURE DEPENDENCE OF N.M.R. ABSORPTION IN SOLID ACETIC ACID AND IN SOME OF ITS CHLORO AND ACID CHLORIDE DERIVATIVES.
A.Peterlin and M.Pintar.
J. chem. Phys. (USA), Vol. 34, No. 5, 1730-2 (May, 1961).

Acetic acid and some of its chloro and acid chloride derivatives with increased substitution of protons by chlorine in the CH_3 group were studed by n.m.r. from −175° −0°C in order to elucidate the temperature dependence of molecular and CH_nCl_{3-n} group mobility and association in the solid state. While CH_3 is free to rotate around the C–C bond, the substitution of one proton by chlorine already results in fixed CH_2Cl group. In order to obtain dimeric association, however, one has to substitute two or all protons by

chlorine. The rotational freedom of single molecules of such associates reappears upon heating to temperatures far below the melting point.

8857 ZEEMAN QUADRUPOLE SPECTRA IN p-DICHLOROBENZENE AND p-CHLOROBENZOIC ACID.

S.Ogawa and K.Ohi.

J. Phys. Soc. Japan, Vol. 15, No. 6, 1064-8 (June, 1960).

Zeeman effects of nuclear quadrupole resonance were studied. For p-chlorobenzoic acid only one C—Cl bond direction was observed. The molecular orientation against the crystal c-axis was obtained by an X-ray measurement. The asymmetry parameter was determined from the Zeeman effect to be 8%. For p-dichlorobenzene, the molecular orientation of the α to the β phase was studied. In most crystals examined,the orientation in two phases is defined respectively. However, there is no relation in two phases. The orientation may be restricted by dislocations which existed previously in the single crystal. The value of the asymmetry parameter obtained is 6% which is smaller than Dean's (1952).

8858 LOW ENERGY PROCESS FOR F-FORMATION IN SF_6.

R.K.Curran.

J. chem. Phys. (USA), Vol. 34, No. 3, 1069 (March, 1961).

A value of $D(SF_5\text{-}F) \leq 3.39 \pm 0.15$ eV is obtained for the dissociation energy of the SF_5 and F bond. This electron impact value is close to the thermochemical value for $D(S\text{-}6F)/6 = 3.11$ eV and it is concluded that there is a constant S-F bond energy in SF_5 and SF_6.

W.J.Orville-Thomas

8859 DISSOCIATION PROCESSES IN ELECTRONICALLY EXCITED MOLECULES. LINEAR CHAIN MODEL.

J.L.Magee and K.Funabashi.

J. chem. Phys. (USA), Vol. 34, No. 5, 1715-25 (May, 1961).

Dissociation mechanisms in a chain of coupled molecules are considered. An attempt is made to look at general features of the influence of electronic coupling on such processes. Actual calculations have only been made for the special case of a chain of H_2^+ ions. The weak-coupling and strong-coupling cases are discussed explicitly, and various criteria for applicability of the special cases are presented in terms of the physical constants of the system.

8860 ISOTROPIC AND ANISOTROPIC HYPERFINE INTERACTIONS IN HYDRAZYL AND CARBAZYL.

N.W.Lord and S.M.Blinder.

J. chem. Phys. (USA), Vol. 34, No. 5, 1693-1708 (May, 1961).

Describes a detailed experimental and theoretical study of the hyperfine structure of diphenylpicrylhydrazyl (hydrazyl) and picrylaminocarbazyl (carbazyl). Both isotropic and anisotropic hyperfine interactions involving the α and β nitrogen atoms are considered. Experimentally, electron spin resonance spectra are observed for dilute solutions of each radical in both fluid and solid media. Concentrations of the order of 0.001 M are employed so as to minimize dipolar and exchange interactions among radicals. The fluid spectra yield, in straight-forward fashion, the absolute values of the isotropic coupling constants $|A_1|$ and $|A_2|$. These splitting parameters are chosen such that a synthesized line shape composed of Gaussians gives optimal reproduction of the observed resonance profile. For the solid solutions, Duco cement (with hydrazyl) and lucite (with carbazyl) provide glassy trapping matrices. It is assumed that the radicals are frozen in an ensemble of random orientations in these solids. Appropriate theoretical line shapes, considering interactions with two magnetic nuclei, are derived, and values assigned to the anisotropic parameters B_1 and B_2 from comparison of experimental and theoretical resonance patterns. The isotropic constants are assumed to be unchanged in the transition from liquid to solid solution. It is found moreover that the inherent Gaussian half-width σ is approximately the same in both states. The parameters assigned through the analysis are Hydrazyl: $A_1 = 9.35 \pm 0.20$ gauss; $A_2 = 7.85 \pm 0.20$ gauss; $B_1 = 6.6 \pm 0.5$ gauss; $B_2 = 5.8 \pm 0.5$ gauss; $\sigma = 3.36 \pm 0.20$ gauss. Carbazyl: $A_1 = 10.2 \pm 0.5$ gauss; $A_2 = 5.8 \pm 0.5$ gauss; $B_1 = 7.7 \pm 1.0$ gauss; $B_2 = 4.1 \pm 1.0$ gauss; $\sigma = 3.4 \pm 0.5$ gauss. Resonance of the hydrazyl-Duco solution during incipient solidification was also observed. In this intermediate medium the anisotropic hyperfine interactions are only partially averaged out by molecular motions. It was found possible to characterize the rigidity of the medium by a parameter λ ($0 \leq \lambda \leq 1$) such that each anisotropic parameter is exhibited in the spectrum as if it were λ times its full value. Various implications of the results on the structure of hydrazyl and carbazyl are considered. One conclusion drawn is that both radicals are largely planar in configuration.

8861 IRRADIATION YIELDS OF RADICALS IN GAMMA-IRRADIATED ICE AT 4.2° AND 77° K.

S.Siegel, J. M.Flournoy and L.H.Baum.

J. chem. Phys. (USA), Vol. 34, No. 5, 1782-8 (May, 1961).

The e.s.r. spectra of both ice and deuterated ice which had been subjected to γ irradiation at 4.2° K are presented and discussed. Experimental radical irradiation yields at 4.2° K are reported for the H_2O system as a function of sustained irradiation dosage. A comparison between the irradiation yields at 4.2° and 77° K is given and the resulting similarities discussed in terms of intra-spur reactions. Finally, preliminary evidence is presented for the existence of an appreciable isotope effect for the irradiati yields in a mixture of H_2O and D_2O.

8862 DISSOCIATION OF MOLECULAR IONS BY ELECTRIC AND MAGNETIC FIELDS. J.R.Hiskes.

Phys. Rev. (USA), Vol. 122, No. 4, 1207-17 (May 15, 1961).

A general discussion of the dissociation of diatomic molecules and molecular ions by electric fields is presented. These calculations pertain primarily to the ground electronic states of the molecular systems. The H_2^+ ion is treated in considerable detail; the required fields for the dissociation range from 10^5 V/cm for the uppermost vibrational state to 2×10^8 V/cm for the ground state. The many-electron homonuclear ions are treated in successive charge states. The HD^+, HT^+, HD, LiH^+, and LiH^{2+} heteronuclear ions are considered. The dissociation of homonuclear ions and heteronuclear ions exhibit distinctly different features. The HD^+ and HT^+ ions are more susceptible to discussion than is H_2^+. The extent to which the dissociation by an electrostatic field and by the Lorentz force, ev × B, are equivalent is considered. The rates of induced dipole transitions to lower vibrational states can be made negligibly small compared with the dissociation rates. The application of this work to particle accelerators and to the injection problem for fusion devices is discussed.

STUDY OF THE N_2O MOLECULE USING ELECTRON BEAMS

See Abstr. 8308

8863 INTERMOLECULAR POTENTIAL OF HELIUM.

A.K.Barua.

Indian J. Phys., Vol. 34, No. 2, 76-84 (Feb., 1960).

The potential energy function for He—He interaction has been obtained on the exp 6-8 model, which contains the dipole—quadrupole interaction term in addition to the dipole—dipole term in the attractive potential, by fitting in second virial and Joule—Thomson coefficient data over a extensive range of temperatures. The necessary quantum corrections have been considered. Excellent agreement is obtained between the values calculated from the potential energy function and the experimental data. On the whole the exp 6-8 potential gives a better fit with the second virial and the Joule—Thomson coefficient data than either the exp 6 or the Lennard-Jones (12 : 6) potential.

8864 FORCE CONSTANTS FOR UNLIKE MOLECULAR INTERACTIONS ON EXP-SIX MODEL FROM INTER-DIFFUSION. R.Paul.

Indian J. Phys., Vol. 34, No. 3, 141-6 (March, 1960).

Force constants for the systems Ne—A, Ne—Kr, A—Kr, He—A, A—Xe, He—Xe, He—Kr and Ne—Xe have been determined from temperature dependence of inter-diffusion coefficients. To simplify matters, the values of α_{12} were taken to be those obtained from the temperature dependence of thermal diffusion or from the combination rules and the method of intersection was employed to give ϵ_{12} and $(r_m)_{12}$. The force constants, thus obtained, have been compared with the values obtained from other methods and satisfactory agreement has been obtained. These force constants have been used to calculate the thermal diffusion factors at different temperatures and reasonable agreement has been obtained except in the case of A—Kr.

8865 EFFECT OF SOLVENT ON THE EXTENSION OF HIGH POLYMER MOLECULE. H.Mizutani.

J. Phys. Soc. Japan, Vol. 15, No. 3, 475-83 (March, 1960).

For clarifying the physical properties of high polymer solutions it is important to investigate the relation of the extension of the high polymer molecule in solution to the potential energies between chain elements of the high polymer molecule and solvent molecules. The present paper gives a theoretical treatment of this relation as a guide to experimental study. The calculation is based on a lattice model. The potential energies of interaction between chain elements and solvent molecules were formulated as precisely as possible, and the expression for the extension of a high polymer molecule wi

ined. The results may be summarized as follows: the express-
by which the end-to-end distance of a high polymer molecule is
ted to the potential energies between chain elements and
ent molecules, and also the expression for a change in end-to-
distance of a high polymer molecule, when it is put from vacuum
solution, were obtained. From these relations the quantity
h determines the extension of a high polymer molecule in
tion is $\Delta E = (E_{pp} + E_{ss})/2 - E_{ps}$ and the quantity which deter-
es the change in extension accompanying the transfer of a high
mer molecule from vacuum to solution is $E_{ps} - E_{ss}/2$. Here
p, $-E_{ss}$ and $-E_{ps}$ are the potential energies between two chain
ents, between two solvent molecules and between a chain
ent and a solvent molecule, respectively.

8866 INTRAMOLECULAR N.M.R. SECOND MOMENT OF THE POLYMER CHAIN. A.Miyake.
Phys. Soc. Japan, Vol. 15, No. 6, 1057-63 (June, 1960).
The second moments of various amorphous vinyl-type polymers
e calculated in terms of the local regularity parameter z, the
tion of gauche-configuration bonds. These values of second
ments at z = 0 are comparable with those calculated for crystal-
polymers. The influence of foreign magnetic nuclei is
ligibly small except for that of F nuclei to H-resonance and
e-versa. The difference between isotactic and syndiotactic
yl polymers was shown. The error caused by omitting the
tributions of farther distant nuclei than those where two C—C
ds and two C—H bonds intervene is estimated as less than a
per cent of the total second moment for the amorphous poly-
ylene.

8867 MOLECULAR STRUCTURE DEDUCED FROM THE STATISTICAL THEORY OF THE ELECTRIC MOMENTS LINEAR POLYMERS. I. STUDY OF POLYOXYETHYLENE-YCOL. V.Magnasco.
ovo Cimento (Italy), Vol. 18, No. 3, 554-69 (Nov. 1, 1960). In
ian.
The mean square electric dipole moment is calculated by a
trix method, assuming the molecule to be flexible, but imposing
ious restrictions on the complete freedom of rotation. Asymp-
c formulae are given for very long chains, and results for finite
ins can be computed numerically. H.N.V.Temperley

8868 PROBABILITY OF INITIAL RING CLOSURE IN THE RESTRICTED RANDOM-WALK MODEL OF A MACRO-MOLECULE. B.J.Hiley and M.F.Sykes.
J. chem. Phys. (USA), Vol. 34, No. 5, 1531-7 (May, 1961).
From a study of the known exact numbers of polygons on the simple quadratic lattice up to 18 sides and on the triangular lattice up to 16 sides, it is concluded that the probability of initial ring closure in two-dimensions of large ring size k varies inversely as $k^{1.83-\theta}$, where $0 \leq \theta \leq 0.05$, and this is significantly higher than the dependence on the inverse square of k found by Wall's statistical investigation. It is found that the mean area of initial ring closures in a plane varies as $k^{3/2}$.

INTERACTION BETWEEN ROD-LIKE POLYELECTROLYTES. See Abstr. 8114

8869 RADIATIVE COLLISIONS BETWEEN MOLECULAR AND ELECTRON BEAMS. V. ANGULAR MOMENTUM DISTRIBUTIONS OF CH* SEPARATING FROM SIMPLE ORGANIC MOLECULES. T.Horie, T.Nagura and M.Otsuka.
J. Phys. Soc. Japan, Vol. 15, No. 4, 641-5 (April, 1960).
For Pt IV see Abstr. 12743 of 1959. Observations were made of electron bombardments of the C_2H_2, CH_2O and CH_3OH molecular jets in vacuum. The free radical $CH^*(B^2\Sigma^-)$ always shows a normal distribution of angular momentum. This experimental result is entirely different from H_2O or H_2O_2. For instance, the distribution curve for CH^* from C_2H_2 shows its maximum near K = 7, while that for OH^* from H_2O_2 near K = 20. This marked difference is discussed, and a statistical interpretation is also given of the angular momentum distribution for CH^* separating from C_2H_2.

8870 DIAMAGNETIC SUSCEPTIBILITY OF Ne, NH_3 and CH_4. K.E.Banyard.
J. chem. Phys. (USA), Vol. 34, No. 1, 338-9 (Jan., 1961).
Some recent determinations of the diamagnetic susceptibility of Ne, NH_3 and CH_4 are compared with some calculations made by the author using analytical central field wave functions including exchange. For Ne and NH_3 the experimental values are higher than the theoretical estimates. A substantial part of the disagreement is due probably to the omission of correlation effects between electrons with anti-parallel spins in the Hartree—Fock treatment.
T.E.Peacock

SOLID-STATE PHYSICS

8871 GROUP THEORETICAL METHODS IN THE QUANTUM PHYSICS OF SOLIDS (SPATIAL SYMMETRY).
V.Sokolov and V.P.Shirokovskii.
pekhi fiz. Nauk (USSR), Vol. 71, No. 3, 485-513 (July, 1960).
Russian.
Review, giving simply and lucidly the main facts concerning the
presentation of space groups (based on more complete presenta-
ns available elsewhere). The general theory is illustrated by a
ef account of one-electron band theory in the linear chain and
simple cubic lattice. Two sections introduce the double groups
sociated with electron spin and the time reversal symmetry.
nglish translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 4,
-66 (Jan.-Feb., 1961)]. R.O.Davies

8872 HALF-CRYSTAL ENERGY CONSTANTS. H.H.Schmidt.
hem. Phys. (USA), Vol. 34, No. 5, 1520-4 (May, 1961).
Tables of the summation constants required for the calculation
urface energies of perfect half-crystals with Lennard-Jones
s of inverse-power pair potential functions have been calculated
g an IBM 709 computer. The tables cover simple cubic, face-
red cubic, body-centred cubic, simple hexagonal, and hexagonal
e-packed structures with face plane orientations having
er indices up to 5 in some cases. The inverse powers included
e tabulation extend from 5 (the lowest power for which these
s converge) to 13. The applications of these results to the
ulation of grain boundary energy and spacing and to the
mation of surface distortion in half-crystals according to
hods previously developed by the author are pointed out. The
gies of h.c.p. and f.c.c. close-packed surfaces are compared
n example.

8873 THEORY OF FORMATION ENERGY OF THE EXTERNAL AND THE INTERNAL SURFACE FOR FREE ELECTRON METALS. A.Sugiyama.
J. Phys. Soc. Japan, Vol. 15, No. 6, 965-82 (June, 1960).
The formula for the surface energy $\sigma_S = k_f^4/160\pi$ is proved to be nearly valid for any self-consistent surface barrier, independently of the surface shape and of the potential form. (1) On the basis of the Friedel theorem (1954) and the extended expression $N(k) \cong k^3V/3\pi^2 - k^2S/8\pi$ of the Weyl—Laue theorem, it is proved that the formula $\sigma_S = k_f^4/160\pi$ holds not only for the plane surface but also for the surface of any shape, provided the surface potential barrier is infinitely high. (2) As the Friedel sum rule for the plane surface potential, the charge neutrality condition in the interior barrier is obtained as

$$\int_0^{k_f} \eta(k_x) k_x \, dk_x = \frac{\pi k_f^2}{8}$$

in terms of the phase shift $\eta(k_x)$. Then the formula $\sigma = \beta\sigma_S$ for the surface energy is derived, where

$$\beta = \frac{80}{\pi} \frac{1}{k_f^4} \int_0^{k_f} \eta(k_x) k_x^3 \, dk_x - 5.$$

By these formulae, the approximate validity of σ_S (or $\beta \cong 1$) for any self-consistent potential on the plane surface can be found. (3) The surface energy of a small spherical cavity is calculated as a function of the radius, assuming the quasi self-consistent infinite barrier for the cavity surface. (4) The formation energy of a atomic vacancy and that of a vacancy pair are discussed as special cases of small volume cavities. The analysis shows the approximate validity of σ_S for any potential form.

LATTICE MECHANICS

A COMBINATORIAL PROBLEM IN CRYSTAL LATTICES.
See Abstr. 8058

8874 A METHOD FOR DETERMINING THE FREQUENCY SPECTRA OF DISORDERED LATTICES IN TWO-DIMENSIONS. P.Dean and J.L.Martin.
Proc. Roy. Soc. A (GB), Vol. 259, 409-18 (Dec. 29, 1960).

A mathematical theorem is introduced which has direct application to the theory of lattice vibrations and is independent of dimensions. It clarifies much of the previous work on disordered one-dimensional systems and provides the basis for a reasonable computational technique for the determination of the frequency spectra of disordered two-dimensional lattices.

8875 INTERACTION OF CONDUCTION ELECTRONS WITH ACOUSTIC WAVES IN SIMPLE SEMICONDUCTORS. N.Mikoshiba.
J. Phys. Soc. Japan, Vol. 15, No. 6, 982-9 (June, 1960).

A semi-classical theory is given of the interaction in single-valley semiconductors with spherical energy surface, using Pippard's approach to the ultrasonic absorption in monovalent metals (1955). For longitudinal acoustic waves, the acoustoelectric effect is identical with that obtained by Weinreich–Holstein's phenomenological approach (1956), if $ql \ll 1$ and $|C| \gg m\omega_p^2/q^2 \gg 2\zeta/3$, where q is the wave number of acoustic waves, C the deformation potential constant and l, m, ω_p, ζ are the mean free path, effective mass, plasma frequency, Fermi energy (or average thermal energy) of conduction electrons respectively. Under such conditions as $ql \gg 1$ and $|C|$ and $2\zeta/3 \gg m\omega_p^2/q^2$, the acoustoelectric effect is essentially identical with that derived from the quantum-mechanical calculation. In the sufficiently low frequency range, where $ql \ll 1$ and $|C|$ and $2\zeta/3 \ll m\omega_p^2/q^2$, the interaction can be described by the term of the electronic viscosity as in monovalent metals. For transverse acoustic waves, C = 0 in cubic crystals and the interaction is analogous to that in monovalent metals, with the two exceptions, that there is no region in which the absorption coefficient depends linearly on the frequency of the waves, and the coefficient approaches the limiting value in the relatively low frequency range.

8876 SOME COMMENTS ON THE THEORY OF THE MÖSSBAUER EFFECT. J.Petzold.
Z. Phys. (Germany), Vol. 163, No. 1, 71-6 (1961). In German.

Although the life-time τ of an excited nucleus is finite, and the coherence length of the emitted γ-ray is of the order of $1/\tau$, the reaction of the γ-emission on the motion of the emitting nucleus is momentary. Some "Mössbauer experiments" are proposed by means of which the properties of a crystal could be measured.

8877 POLARIZATION OF Co^{57} IN Fe METAL. J.G.Dash, R.D.Taylor, D.E.Nagle, P.P.Craig and W.M.Visscher.
Phys. Rev. (USA), Vol. 122, No. 4, 1116-24 (May 15, 1961).

A study was made of the effect of low temperatures on the resonant emission and absorption of 14.4 keV Mössbauer radiation from Fe^{57} in Fe metal. Analysis of intensity changes in the hyperfine spectrum is made in terms of the Zeeman level splittings of the ground states of Fe^{57} absorbing nuclei and of the ground states of Co^{57} parent nuclei. The theory for the temperature dependence is developed in terms of the properties of the Co^{57} decay and of the subsequent gamma transitions. Experiments were carried out with a source of Co^{57} nuclei in Fe metal at temperatures between 4.5° and 0.85°K. The experimental results, analysed in terms of the theory, yield a value of the hyperfine magnetic field at the Co^{57} nuclei. Comparison of the result with other pertinent experimental values indicated that depolarization of the nuclei by the K-capture decay of Co^{57} was not evident in the material used.

INTERNAL FIELDS IN IRON GARNETS, USING THE MÖSSBAUER EFFECT IN Fe^{57}. See Abstr. 7769

Thermal Properties

8878 THERMODYNAMIC PROPERTIES OF AN ISOTOPIC MIXED CRYSTAL. J.Pirenne.
Physica (Netherlands), Vol. 27, No. 4, 385-402 (April, 1961).

An expression of the frequency distribution of the crystal formed by a single element possessing several isotopes, whose atoms are assumed to be distributed at random throughout the latt points, has been derived previously (Abstr. 3447 of 1958). It is no applied to the computation of the thermodynamic properties chang resulting from the isotope mixing.

8879 THE HEAT CAPACITIES OF SOME COPPER–MANGANESE ALLOYS. J.M.Titman.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 807-10 (March, 1961).

The anomalous behaviour of the heat capacities at the Néel points of copper–manganese alloys containing 80 and 85 at.% Mn is more marked than that observed in other metallic antiferromagnetics. The entropies associated with the anomalies are 0.20 0.35 cal mol^{-1} deg^{-1}, respectively, and are significantly less than value $R\ln(2S + 1)$ predicted by localized theories of antiferromagnetism. It is concluded that these results indicate that the appropriate model of antiferromagnetism in metals is not one bas on completely localized moments.

8880 THE USE OF ELECTRON GAS MODIFICATION IN TH EVALUATION OF THE VIBRATION FREQUENCIES AND THE SPECIFIC HEAT OF LITHIUM. B.Dayal and B.Sharan
Proc. Roy. Soc. A (GB), Vol. 259, 361-9 (Dec. 29, 1960).

A secular determinant for the determination of vibration fre quencies of lithium was set up by Launay's method which takes th electron gas into account. Theoretical elastic constants were use in the calculation of the force constants. Frequencies were calcu lated for 47 points of the first Brillouin zone which gives the valu of 3 × 1000 = 3000 frequencies by symmetry. Specific heats were calculated by numerical computation in the range 300° to 6° K and show good agreement with the experimental data. The agreemen below liquid-air temperatures is surprising in view of the known phase transformation of lithium.

8881 SPECIFIC HEAT OF $GdCl_3.6H_2O$ IN THE TEMPERATURE RANGE BETWEEN 1.1° AND 260°K. K.H.Hellwege, F.Küch, K.Niemann and W.Pfeffer.
Z. Phys. (Germany), Vol. 162, No. 4, 358-62 (1961). In Germa

The specific internal energy and the specific entropy of the lattice were also determined.

8882 NUCLEAR MAGNETIC SPECIFIC HEAT IN TWO FERROMAGNETIC IRON ALLOYS. C.T.Wei, C.H.Cheng and P.A.Beck.
Phys. Rev. (USA), Vol. 122, No. 4, 1129-30 (May 15, 1961).

From the nuclear magnetic specific heat, measured at 1.6° to 4.2°K, H_{eff} at the Co nuclei in $Co_{0.3}$ $Fe_{0.7}$ was calculated to be 312 k0e, while H_{eff} at the V nuclei in $V_{0.33}$ $Fe_{0.67}$ is 61 k0e, or less Both of these alloys are body-centred cubic and ferromagnetic. The large difference in the H_{eff} values may be associated with the fact that in $Co_{0.3}$ $Fe_{0.7}$ the Co^{59} nucleus is located in an atom with appreciably polarized 3d electrons, while in $V_{0.33}$ $Fe_{0.67}$ the V^{51} nucleus is the only abundant nuclide magnetic moment and the atomic moment of V is very small or zero. Since in ferromagnet alloys the polarization of the core s electrons is expected to be m stronger in those atoms which do have polarized d electrons than adjacent atoms which do not, the above results suggest that, in the alloys investigated, the dominant contribution to He_{eff} arises through Fermi contact interaction from the polarization of the co s electrons, as found for iron by Hanna et al. (Abstr. 11827 of 196

8883 DETERMINATION OF SOME PHYSICAL PROPERTIE OF HEAVILY COMPRESSED METALS. Yu.N.Ryabinin, K.P.Rodionov and E.S.Alekseev.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 150-3 (July, 1960). In Russian.

Based on the concepts of the classical theory of solid state, expressions were derived for the pressure-dependence of the Debye temperature, coefficient of thermal expansion, and m.p. of metals. The calculated values of the latter characteristic were i good agreement with the experimental data. M.H.Slobod

8884 DEBYE Θ AND COMPRESSIBILITY. III. CUBIC METALS. S.S.Mitra and S.K.Joshi.
ysica (Netherlands), Vol. 27, No. 4, 376-80 (April, 1961).

For Pt II see, Abstr. 17878 of 1960. It is shown that for crystals onging to the cubic class, general relations can be obtained nnecting the Debye characteristic temperature, Θ, and the com-ssibility, χ, and that they do not depend on the nature of the ential energy of the crystal. An error in the literature is pointed in connection with a Θ, χ relation for the ionic crystals of the Cl type. The following formulae are obtained for the metals onging to the cubic class:

$$\Theta = \frac{h}{k}\frac{1}{2\pi}\left(\frac{6a}{m\chi}\right)^{\frac{1}{2}}$$

the body centred cubic structure and

$$\Theta = \frac{h}{k}\frac{1}{2\pi}\left(\frac{4.5a}{m\chi}\right)^{\frac{1}{2}}$$

the face centred cubic structure, where h and k are Planck's and ltzman's constants, a the lattice constant and m the atomic mass. s calculated from these relations compare well with their perimental" values.

8885 A STUDY OF THERMAL EXPANSION OF GaAs AND ZnSe. S.I.Novikova.
. tverdogo Tela (USSR), Vol. 3, No. 1, 178-9 (Jan., 1961). Russian.

GaAs and ZnSe were prepared from very pure components. eir thermal expansion was measured between 20° and 360°K. e linear coefficient α of both compounds fell with decrease of nperature, passing through zero at ≅ 55°K for GaAs, and at 4°K for ZnSe. In both cases there was a negative minimum of $\alpha_{min} = -0.5 \times 10^{-6}\,deg^{-1}$ at ≅ 40°K for GaAs; $\alpha_{min} = -3.10 \times 10^{-6}$ $^{-1}$ at 36°K for ZnSe. [English translation in: Soviet Physics—id State (USA)]. A.Tybulewicz

8886 THE REDUCED EQUATION OF STATE OF THE INERT GAS SOLIDS AT THE ABSOLUTE ZERO. Zucker.
c. Phys. Soc. (GB), Vol. 77, Pt 4, 889-900 (April, 1961).

It is shown that a law of corresponding states exists amongst the rt gases in the solid phase even when quantum effects are large. e theoretical treatment is based on the Einstein model of a stal modified to account for large vibrations of the crystal ms. Using a Lennard-Jones 12–6 potential for the interaction rgy between a pair of atoms, reasonable agreement is obtained ween theoretical and experimental values for the equilibrium umes and energies of the rare gas crystals at the absolute o.

8887 LOW-TEMPERATURE THERMAL RESISTANCE OF N-TYPE GERMANIUM. R.W.Keyes.
ys. Rev. (USA), Vol. 122, No. 4, 1171-6 (May 15, 1961).

It is proposed that the scattering of phonons by donors in rmanium at low temperatures results from the large effect of ain on the energy of an electron in a hydrogen-like donor state. alculation of the thermal conductivity with this scattering chanism is presented. Reasonable agreement with the following tures of the observed thermal conductivity is obtained: the very ge scattering power of donors, the difference between the ttering powers of antimony and arsenic, a temperature depen-nce of thermal conductivity stronger than T^3, and a dependence he scattering on number of occupied donors rather than on the al impurity concentration.

8888 PHONON SCATTERING IN SODIUM CHLORIDE CONTAINING OXYGEN. M.V.Klein.
ys. Rev. (USA), Vol. 122, No. 5, 1393-1402 (June 1, 1961).

The thermal conductivity of supposedly pure NaCl crystals m several sources was found to vary by as much as two orders magnitude at low temperatures. The conductivity of Harshaw stals was particularly low. This effect was quantitatively re-ed to the presence of an ultraviolet absorption band at 185 mμ wn to be caused by oxygen-containing anionic impurities. Both nomena were considerably reduced by treatment of the crystals chlorine vapour at high temperatures; conversely both were anced by growing crystals from melts doped with NaOH, NaOD, Na_2O_2. There was little evidence, however, that the dopants eared in these forms in the crystals. Infrared measurements and pH titrations suggested that the most likely result of the dopings was to introduce carbonate into the crystals. The active impurity scattered phonons very strongly at low temperatures: at 5°K approximately 3000 times more strongly than is usually observed for point defects. The cross-section was proportional to the first power of the phonon wave-vector and was found to be independent of the defect concentration. No detailed model was found to explain these results. A likely explanation would be in terms of an interaction between the phonon field and localized modes of the scattering centre.

8889 THERMAL CONDUCTIVITY OF CaF_2, MnF_2, CoF_2, AND ZnF_2 CRYSTALS. G.A.Slack.
Phys. Rev. (USA), Vol. 122, No. 5, 1451-64 (June 1, 1961).

The thermal conductivities of the single crystals were measured over the temperature range from 3°K to 300°K. In this series, CaF_2 and ZnF_2 are diamagnetic, whereas MnF_2 and CoF_2 are antiferromagnetic. All four crystals have nearly equal thermal conductivities at room temperature, but differ at lower temperatures. CaF_2, which is nearly isotopically pure, exhibits an exponential rise in conductivity with decreasing temperature characteristic of umklapp processes. ZnF_2 shows only traces of such umklapp behaviour because its conductivity is limited by isotope and impurity scattering. Small cusps are observed in the conductivities of MnF_2 and CoF_2 at their Néel temperatures of 67°K and 38°K, respectively, which indicate the presence of phonon–magnon scattering. Some experimental details concerning thermal conductivity measurements and the behaviour of gold–cobalt thermocouples are also given.

8890 THE LAW OF WIEDEMANN AND FRANZ. G.V.Chester and A.Thellung.
Proc. Phys. Soc. (GB), Vol. 77, Pt 5, 1005-13 (May, 1961).

The exact expressions for the transport coefficients of a metal are used to show that the Wiedemann–Franz law is valid provided that (a) the electrons do not interact with each other and form a degenerate Fermi–Dirac assembly, (b) the scattering of the electrons is due to impurities or lattice vibrations and is elastic. The derivation is valid no matter how strong the scattering and it is therefore more general than the usual weak-coupling derivation of the Wiedemann–Franz law.

8891 THEORY OF THERMAL CONDUCTIVITY OF SOLIDS AT LOW TEMPERATURES. P.Carruthers.
Rev. mod. Phys. (USA), Vol. 33, No. 1, 92-138 (Jan., 1961).

A comprehensive discussion of certain aspects of the lattice thermal conductivity of solids at low temperatures. The emphasis is generally upon determining the adequacy and range of validity of the various methods used in the analysis of experimental results. After an introductory section on lattice vibrations, three-phonon processes and phenomenological theory, detailed consideration is given to strain-field scattering, mass-difference scattering and boundary effects. J.W.Leech

CHANGE OF THERMAL AND ELECTRICAL CONDUCTIVITY OF FERROMAGNETICS IN A MAGNETIC FIELD. See Abstr. 9034

ELECTRON STATES

8892 ELECTRONIC ENERGY BANDS OF PARTIALLY DISORDERED ALLOYS. A.Corciovei and D.Grecu.
C.R. Acad. Sci. (France), Vol. 252, 1582-4 (March 13, 1961). In French.

See Abstr. 3630 of 1961.

8893 THE ORDINARY TRANSPORT PROPERTIES OF THE NOBLE METALS. J.M.Ziman.
Advances in Phys. (GB), Vol. 10, 1-56 (Jan., 1961).

The Fermi surfaces in Cu, Ag and Au are known to be greatly distorted, with thick "necks" passing through the zone boundaries. The paper enquires into whether such an electronic structure is quantitatively consistent with the observed transport coefficients. The mathematical model is quite simple; the shape of the Fermi surface is made to depend on a single parameter which can be interpreted as the pseudo-potential of the {111} atomic planes acting on an orthogonalized plane wave, giving rise to an energy gap of 5/10 eV at the zone boundaries. Various integrals over the Fermi surface can then be evaluated by elementary methods, and compared with the corresponding experimental quantities. The electronic

specific heat and optical mass in the pure metals are consistent with the model. The galvanomagnetic effects are shown to depend a great deal on the anisotropy of the electron relaxation time, whose variation with energy is also probably the main determinant of the sign of the thermoelectric power. A better theory of electron–phonon interaction is needed before this, and the electrical and thermal conductivities, can be calculated accurately. There is no evidence which directly contradicts the rigid band model, except perhaps the effect of alloying on the optical absorption edges and on the electronic specific heat, but there are still many experimental and theoretical gaps in present knowledge.

8894 EFFECT OF INTERACTIONS ON DETERMINATION OF FERMI SURFACES. E.A.Stern.

Phys. Rev. (USA), Vol. 122, No. 6, 1773-80 (June 15, 1961).

The effect of both electron–electron and electron–phonon interactions on a degenerate electron gas in a uniform positive background is considered. It is shown that when electron–electron interactions alone are considered the free-electron mass is still measured by cyclotron resonance, the Faraday effect, and optical constants. However, the period of the de Haas–van Alphen oscillations is changed from what one calculates neglecting interactions and is changed in the same way as the specific heat. When electron–phonon interactions are added everything changes. In particular, it is shown that the cyclotron mass is no longer the free value, and the de Haas–van Alphen period and the specific heat are changed in different ways. Comparison with measurements on aluminium, which approximates the model used, shows that both electron–phonon and electron–electron effects are important and of the same magnitude.

8895 ONE-DIMENSIONAL CHAINS WITH RANDOM SPACING BETWEEN ATOMS. R.E.Borland.

Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 705-11 (March, 1961).

The calculation of the integrated density of states for positive electron energies of a one-dimensional chain of atoms whose spacing is given by a probability distribution function is reduced to the form of an integral equation. This equation is simplified considerably when the atoms are distributed at random. In this case, an explicit solution for the integrated density of states is found, which is rigorously valid for δ-function atomic potentials, and may be valid generally. It is shown that the solution gives good agreement with the machine results of Lax and Phillips (Abstr. 783 of 1959) for the δ-function case.

8896 MAPPING OF THE FERMI SURFACE BY A COMBINATION OF GEOMETRIC RESONANCE AND TILT EFFECT. H.N.Spector.

Phys. Rev. Letters (USA), Vol. 6, No. 8, 407-8 (April 15, 1961).

A new method of mapping Fermi surfaces is proposed which involves a simultaneous geometric resonance and tilt effect experiment. Provided $\omega\tau$ is high enough, the orbits which keep in phase with the sound wave will dominate the ultrasonic attenuation and thus non-extremal diameters of the Fermi surface can be measured. The Fermi velocities must also be small for the angles of tilt to be measurably large. The effect should be most easily observable in high-purity samples of semi-metals. M.G.Priestley

8897 COLLECTIVE OSCILLATIONS OF A SYSTEM OF HOLES IN THE PRESENCE OF PHONONS. A.Coumes.

J. Phys. Radium (France), Vol. 21, No. 4, 229-32 (April, 1960). In French.

The screening effect of light particles surrounding heavy particles (the charge of which is of the opposite sign) can be characterized independently of the screened particles. The collective oscillations of holes are derived by analogy with phonons. The damping of these oscillations is shown to be very small.

8898 IONIZED STATES IN A ONE-DIMENSIONAL MOLECULAR CRYSTAL. R.E.Merrifield.

J. chem. Phys. (USA), Vol. 34, No. 5, 1835-9 (May, 1961).

Generalization of the theory of excitons in molecular crystals to include ionized states is carried out for an idealized one-dimensional model for which the exact wave-functions and energy levels can be derived. The ionized states are found to form a progression of bands corresponding to bound states of the electron and hole. The bound levels converge to a band of free states in which the electron and hole move independently and can carry an electric current. The lowest-lying ionized states may interact significantly with the un-ionized molecular exciton states and give rise to weak charge-transfer absorption bands.

8899 ENERGY, SPECIFIC HEAT, AND MAGNETIC PROPERTIES OF THE LOW-DENSITY ELECTRON GAS. W.J.Carr, Jr.

Phys. Rev. (USA), Vol. 122, No. 5, 1437-46 (June 1, 1961).

A perturbation expansion in powers of $r_s^{-1/2}$ is used to investigate the ground-state energy of a dilute electron gas, the result being, in Rydberg units per particle,

$$E = -1.792/r_s + 2.66/r_s^{3/2} + b/r_s^2 + O(1/r_s^{5/2}) + \\ + \text{terms falling off exponentially with } r_s^{1/2}.$$

The dimensionless parameter r_s is the radius of the unit sphere in Bohr radii. The term in r_s^{-1} is the energy of a body-centred cubic lattice of electrons as calculated by Fuchs; the $r_s^{-3/2}$ term is the zero-point vibrational energy of the lattice, as obtained from a calculation of the normal modes, the result differing only by a small amount from the values estimated by Wigner (1938); and br is the first-order effect of anharmonicities in the vibration. The constant b has been estimated, its magnitude being smaller then unity. The vibrational part of the specific heat is calculated, and first-order approximation is obtained for the exponential terms in the energy. Part of this energy comes from exchange, which leads to the result that, except for very low densities ($r_s >\sim 270$), the electron spins are antiferromagnetically aligned. An order of magnitude for the Néel temperature is calculated.

8900 FERROMAGNETISM OF AN ELECTRON GAS. M.Shimizu.

J. Phys. Soc. Japan, Vol. 15, No. 3, 376-406 (March, 1960).

Magnetism, especially ferromagnetism, of an electron gas is studied on the basis of the Bohm–Pines collective description of electron interactions. Exchange interactions are derived from the screened Coulomb interaction, the interaction obtained from the second-order perturbation of the screened Coulomb interaction, and the weak interaction coming from the interaction between plasma and individual electrons. An effective mass for the electron is assumed. The total energy of the electron gas in the ferromagnetic state is compared with that in the non-ferromagnetic state, and the conditions of ferromagnetism for the electron gas are discussed. The one-electron approximation being adopted, the effective number of magnetic carriers in the electron gas is expressed as a function of temperature and magnetic field. Using the Weiss approximation the spontaneous magnetization at an arbitrary temperature is expressed in terms of this effective number and the molecular field obtained from the proper average of the exchange interaction. At low temperatures, the spin-wave approximation is adopted. The Curie temperature, the paramagnetic susceptibility above the Curie point, and the temperature variation of spontaneous magnetization at low temperatures are determined as functions of the effective mass and the electoon mean distance. Using the effective masses determined so as to explain the experimental values of the electronic heats, a comparison is made with experimental values for Ni, Co and Fe. It shows satisfactory agreement in the case of positive hole gas. The strong paramagnetism of γFe, Pd and Pt are also satisfactorily explained, and the inverse of their susceptibilities is well expressed as the sum of an constant term and the term proportional to T^2 at comparatively lower temperatures.

8901 INFLUENCE OF A STATIC ELECTRIC FIELD ON POSITRONIUM FORMATION IN POLYMERS. A.Bisi, F.Bisi, A.Fasana and L.Zappa.

Phys. Rev. (USA), Vol. 122, No. 6, 1709-10 (June 15, 1961).

The effect was detected by a study of the time delay spectrum of the annihilation γ-rays. Typical nonpolar polymers, like polyethylene and Teflon, show a strong decrease in positronium formation with increasing electric field (33% and 13%, respectively, at 50 kV/cm), while no effect was found in polar polymers, like Lucite, nylon, and polyvinyl chloride.

DEFECT PROPERTIES

8902 MOBILITY OF RADIATION-INDUCED DEFECTS IN GERMANIUM. P.Baruch.

J. appl. Phys. (USA), Vol. 32, No. 4, 653-9 (April, 1961).

The motion of irradiation-produced defects in germanium was observed under the influence of the electric field of a reverse-biased p–n junction. The defects were created with 1 MeV electrons or Co^{60} gamma rays, and the spatial distribution of the defects was

ained from the bias dependence of the junction capacity. Motion he electric field was observable between 40-70°C and corres-ds to negatively charged centres with a mobility of 2.6×10^{-14} V^{-1} sec^{-1} at 65°C. The activation energy of the mobility is ut 1 eV. The centres are thought to be those which have prev-sly been observed to anneal thermally. No observable effect was nd for those defects which anneal at lower temperatures. Tenta-interpretations are given.

8903 POINT-DEFECT MIGRATION AND BINDING IN METALS. A.Sosin.
s. Rev. (USA), Vol. 122, No. 4, 1112-16 (May 15, 1961).

The kinetics of decay of an excess defect concentration in als is examined with special attention to the initial stages of ay. A particular case, excess vacancy migration to sinks in a htly impure metal, is treated in detail; analogue computer plots sothermal and constant-tempering-rate recovery studies are sented and analysed. Initial recovery is determined by the ration energy only; final recovery is determined by an energy erally less than the sum of the migration plus vacancy—urity binding energy but more than the migration energy alone. ial and final recovery are easily resolved into two annealing ges. The intermediate recovery range may actually give rise to esistivity increase.

8904 PRESSURE EFFECT ON VACANCY MIGRATION RATE IN GOLD. R.M.Emrick.
s. Rev. (USA), Vol. 122, No. 6, 1720-33 (June 15, 1961).

The effect of hydrostatic pressures of 10 000 kg/cm² on the aling rate of vacancies quenched in gold was studied. High-ity gold wires were quenched from 700°C, trapping in the equilib-n concentration of vacancies at that temperature. The vacancies e then observed to anneal out in the vicinity of room temperature arious pressures by observing the decay of the quench-induced dual resistance increase. A simple relation for the temperature endence of the annealing rate is derived, assuming a random dis-ution of vacancies and vacancy sinks. By applying thermodyna-relations to the expression for the vacancy annealing rate, a me of motion is derived in terms of the experimentally deter-ed pressure effect on the annealing rate. For gold, the motional me is found to be 1.50 ± 0.14 cm^3/mole compared with the atomic me of 10.2 cm^3/mole. A hard-spheres model for the jump pro-s predicts about a one atomic volume increase of the lattice for saddle-point configuration as well as a one atomic volume in-se when a vacancy is formed. Many theoretical calculations of lattice distortion around a vacancy and indirect experimental surements of the volume change of the lattice on forming a vac-y indicate that there is considerable relaxation of the neighbouring ns about a vacancy. These results are used to explain the small e of the motional volume. Activation volumes derived from mea-ements of the effect of pressure on the rate of self-diffusion are to be consistent with the present experimental value.

8905 THE KINETICS OF IMPURITY PRECIPITATION ON DISLOCATIONS: SMALL DRIFT THEORY.
ullough and R.C.Newman.
l Mag. (GB), Vol. 6, 403-17 (March, 1961).

A perturbation solution of the differential equation controlling migration of impurity atoms to a dislocation is given and ndary conditions appropriate to precipitation on the dislocation derived. Numerical results within the range of validity of the turbation analysis are obtained and use to discuss the ageing of bon and nitrogen in iron.

8906 ON THE ORIGIN OF DISLOCATIONS IN SOLIDS. SOME ASPECTS OF THE SOURCES ENCOUNTERED IN METALS.
ourdeux and A.Berghezan.
.. Acad. Sci. (France), Vol. 252, No. 10, 1462-4 (March 6, 1961).
French.

Various metal thin films were examined by transmission elec-n microscopy. After quenching the specimens, previously annealed, authors observe that the precipitate particles blow off dislocation ps (Abstr. 9974 of 1957). Also these particles are a source of ocation loops at ordinary temperatures during deformation. eral other types of dislocation sources are observed and dis-sed. R.Bullough

8907 CROSS SLIP AND CROSS CLIMB OF DISLOCATIONS INDUCED BY A LOCKED DISLOCATION. J.C.M.Li.
ppl. Phys. (USA), Vol. 32, No. 4, 598-99 (April, 1961).

The nature of double cross slip of screw dislocations as induced by a locked parallel screw dislocation, that of edge dislocations as induced by a locked edge dislocation through climb, and that of the cross climb of edge dislocations as induced by another edge dislocation through slip are studied in the light of the interaction of the mutual stress fields of the dislocations. Some quantitative calculations of the multiplication of a single loop and of the growth of slip bands in LiF are given; satisfactory agreement is found with the experimental results of Johnston and Gilman (Abstr. 4019 of 1959; 7885 of 1960). A mechanism for linear hardening at low stresses is suggested.

8908 ON DISLOCATION INTERACTIONS IN THE F.C.C. LATTICE. J.P.Hirth.
J. appl. Phys. (USA), Vol. 32, No. 4, 700-6 (April, 1961).

Long- and short-range interactions of dislocations and the likely result of dislocation intersections in f.c.c. lattices are assessed. Of the 24 possible secondary glide systems which could interact with a primary system, 12 promote work hardening by providing strong blocks to primary glide propagation, while 12 provide only weak blocking or no blocking. The original Lomer—Cottrell barrier is found not to exist as an extended barrier; however, several other strong barriers may be extended.

8909 DISLOCATIONS IN PURE IRON FOILS DEFORMED BY BENDING. T.Yamashita and Y.Taneda.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1015-21 (June, 1960).

Dislocations were observed by transmission electron microscopy. The parallel dislocations up to several μ length or more, presumably intersecting but no degenerating dislocations, loops and half loops of dislocations were found. The average density of dislocations in a well annealed state and in a bent foil were respectively, 10^6–10^8/cm² or less and 10^{11}–10^{12}/cm². That the formation of dislocations is due to the bending is concluded from the increase in the density of dislocations and from the stress present in the foil. To interpret the results obtained, a three-dimensional agrrangement of dislocations in the specimen is proposed. A simple method for the preparation of a thin foil is also developed.

DISLOCATIONS IN SINGLE-CRYSTAL SILICON.
See Abstr. 7837

8910 ELECTRON MICROSCOPIC OBSERVATION OF DISLOCATIONS IN FLUORITE.
E.Schüller and S.Amelinckx.
Naturwissenschaften (Germany), Vol. 47, No. 21, 491-2 (1960).

Thin flakes of calcium fluoride were prepared by cleavage, mechanically polished and further thinned using conc. H_2SO_4 at 130°C, the latter process removing about 7 μ/min. The flakes, especially at their edges and near holes, were then thin enough for electron microscopy. The contrast caused by strain near dislocations was high, hence the latter were easily seen. The dominant mode of dislocation multiplication is thought to be repeated cross-slip. R.Reed

8911 ELECTRON MICROSCOPE OBSERVATION OF PRECIPITATES ON GROWN-IN DISLOCATIONS IN MgO.
J.D.Venables.
Phys. Rev. (USA), Vol. 122, No. 5, 1388-9 (June 1, 1961).

The defect structure of undeformed, single-crystal, Norton MgO was examined by transmission in the electron microscope. It was observed that precipitate particles in the form of 0.2 μ diameter spheres and short rods are present in large numbers on as-grown dislocations. By using special etching and optical techniques which are described, the concentration of the precipitate spheres is shown to average 10^9 "balls"/cm³ (but range from 10^7 to 10^{10} "balls"/cm³) for a large number of samples examined. Qualitative evidence is presented which indicates that these precipitates are the origin of Tyndall scattering frequently observed in MgO.

8912 SHAPE OF NUCLEUS DOMAIN ANCHORED TO A SCREW DISLOCATION IN FERROELECTRIC CRYSTAL.
H.Takahasi, T.Nakamura and Y.Ishibashi.
J. Phys. Soc. Japan, Vol. 15, No. 5, 853-9 (May, 1960).

The elastic deformation around a screw dislocation which has a spontaneous shear strain in ferroelectric state is solved, using the relaxation method, taking into account the nonlinear stress–strain relationship of the ferroelectrics. The result turns out to contain a discontinuity corresponding to the domain boundary. This domain is plate-like in the absence of the external field but becomes

wedge-shaped by application of a field. The relaxation process is analogous to the one used in solving the ordinary Laplace equation but differs in that the stress is put to zero when the strain is less than a certain magnitude. The calculation took a few hours on a digital computer PC-1.

EXPERIMENTAL EVIDENCE OF ELECTRIC CHARGES IN IONIC CRYSTALS ALONG SLIP PLANES. See Abstr. 7827

Diffusion

8913 DELINEATION OF THE PROBLEM OF SORET DIFFUSION. R.A.Oriani.
J. chem. Phys. (USA), Vol. 34, No. 5, 1773-7 (May, 1961).

The phenomenological heat of transport is analysed for the simple cases of self-diffusion via a vacancy mechanism and of diffusion of solutes in interstitial solid solutions. The heat of transport is shown to be equal to the sum of an energy-conversion term and an energy-transport term. The latter is a function of the details of the mechanism and is of kinetic character; a positive contribution is made to it by the localized normal modes about a solute atom. The energy-conversion term has a thermodynamic character once the diffusion mechanism is specified, and by its use one can decompose energies of solution or of vaporization into a part associated with the solute atom and another part associated with the solvent lattice.

8914 ERRATUM: DIFFUSION AND EXCHANGE OF Zn IN CRYSTALLINE ZnS. E.A.Secco.
J. chem. Phys. (USA), Vol. 34, No. 5, 1844 (May, 1961).
See Abstr. 5183 of 1959.

Colour Centres

8915 LOW-TEMPERATURE OPTICAL BLEACHING OF F CENTERS IN KCl. A.R.Reinberg and L.I.Grossweiner.
Phys. Rev. (USA), Vol. 122, No. 6, 1734-41 (June 15, 1961).

Optical bleaching of F-centres in X-rayed and additively coloured KCl was studied at 77°K with pulse irradiation methods. Constant "F-light" incident on the coloured crystal establishes a photostationary equilibrium between F and F' centres. The application of a high-intensity light flash of appropriate spectrum displaces the system from equilibrium to either direction. The return to equilibrium is exponential in time, with a rate controlled by the intensity and spectrum of the constant light, but not depending on the F-centre concentration or the method of coloration. The results are in agreement with a kinetic model involving only F-to-F' centre interconversions. Prior room-temperature optical bleaching inhibits the extent and rate of low-temperature bleaching, probably due to the growth of other bands under the F-band. The saturation of the extent of bleaching at high pulse-light intensity and a lower bleaching efficiency for the additively coloured crystal indicate that the distribution of F-centres in the crystal is significant in low-temperature bleaching.

8916 PHOTO- AND THERMOCHEMICAL REACTIONS IN POTASSIUM CHLORIDE CRYSTALS — A QUANTITATIVE STUDY OF THE M CENTRE. T.Tomiki.
J. Phys. Soc. Japan, Vol. 15, No. 3, 488-510 (March, 1960).

By experiments upon the thermal stability of the M, R and N centres in KCl orystal coloured additively, it was revealed that R_1 and R_2 centres dissociated thermally into F, M and N centres above 50°C, N centres dissociate into F and M centres above 100°C and M centres dissociated into F centres above 130°C. The relaxation time τ for the dissociation process of the M centre is expressed by $\tau^{-1} = 2 \times 10^{12} \exp(-1.31/kT)$ sec^{-1} for kT in eV. The corresponding experiment on the R centre was unsuccessful. With use of the above properties of photochemical products, the number of the F centre corresponded to one M centre was determined with high precision. In addition to this, the quantum yield of the M centre in the photochemical reaction with M band light was investigated as a function of temperature. Combining these two experiments with a quantitative analysis of dichroism both in the F and M bands, it is concluded that the M centre is a one-electron centre, that the second M band exists in the F band region, that the absorption considered to be a continuum of the M centre exists in the short wavelength branch of the F band and that the oscillator strength of the M main band is assigned to 0.83. The reciprocal of the quantum yield of the M centre is expressed by $1 + 1.4 \times 10^{-7} \exp(0.50/kT)$ for kT in eV. It is also concluded that the R centre has another absorption in the spectral region of the F band.

8917 INTERACTION OF EXCITON WITH ELECTRON TRAPPING CENTERS IN ALKALI HALIDE CRYSTALS. II. QUANTUM YIELD FOR THE U → F CONVERSION AND ITS DEPENDENCE ON U-CENTER CONCENTRATION.
M.Ueta, M.Hirai and H.Watanabe.
J. Phys. Soc. Japan, Vol. 15, No. 4, 593-602 (April, 1960).

For Pt I see Abstr. 10240 of 1959. The quantum yield for the photochemical conversion of a U centre to an F centre as a function of illuminating photon energy was investigated in KCl, KBr and their mixed crystals. For photons in the U-absorption band the yield increases with the illuminating photon energy. It has been determined that the conversion occurs with a maximum yield of nearly unity for photons both in the shorter wavelength tail of the U-absorption band and in the fundamental absorption tail–exciton band. The dependence of the yield of exciton-induced U → F conversion upon the temperature and U centre concentration has also been studied. The yield of unity is independent of the concentration in the range higher than 1.0×10^{17}/c.c.; however, it drops appreciably below 5×10^{16}/c.c., indicating that the exciton is movable and its maximum length of migration is of the order of 3×10^{-6} cm.

8918 DICHROISM OF Z BANDS.
M.Ishiguro, E.Sugioka and N.Takeuchi.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1302-7 (July, 1960).

The dichroic properties of Z bands and their correlation to that of the F band were studied on NaCl:Sr and Kcl:Sr single crystals. From the experiment on the anisotropic bleaching, the Z_1 centre was found to have high symmetry in agreement with the result of a paramagnetic resonance experiment. The Z_2 band showed dichroism when irradiated with [010] polarized light in the Z_2 or F band at room temperature, accompanying the dichroism of opposite sign in the F band. This is another example of the correlation in dichroism between two absorption bands as shown in the F-M system which has been found by Van Doorn and Haven (1955). It is, however, questionable simply to decide the symmetry of the Z_2 centre from the dichroism mentioned above, because in the case of KCl:Sr, the peak position is shifted to a shorter wavelength than the normal Z_2 band.

8919 INFLUENCE OF DISLOCATION ON DIFFUSION RATE OF F CENTERS IN KCl. H.Mizuno and S.Miyamoto.
Phys. Rev. Letters (USA), Vol. 6, No. 8, 410-11 (April 15, 1961).

Single crystals of KCl were subjected to pressure so that deformation resulted in a single pair of mutually perpendicular sl systems. The crystals were then additively coloured at 450°C in potassium vapour for 20 hours, showing a marked concentration gradient of colour centres. The measurement of absorption shows that the rate of diffusion along the orientation of the dislocations is three times that in perpendicular directions. G.F.J.Garli

Radiation Effects

8920 PROTECTION AGAINST RADIATION DAMAGE IN POLYMETHYLMETHACRYLATE BY HIGH-ENERGY ELECTRONS AND BY ULTRAVIOLET LIGHT.
D.G.Gardner and L.M.Epstein.
J. chem. Phys. (USA), Vol. 34, No. 5, 1653-60 (May, 1961).

The protection against damage caused by ultraviolet light and 2 MeV electrons afforded polymethylmethacrylate by small amou of such additives as pyrene, p-terphenyl, xylene, benzene, and lea stearate is examined. The results are discussed in terms of a model involving energy transport by both excited and ionized state

EFFECT OF FISSION SPECTRUM NEUTRONS ON n-TYPE GERMANIUM. See Abstr. 8941

8921 EVIDENCE OF TRAPPED N ATOMS IN X-RAY IRRADIATED NaN_3.
G.J.King, F.F.Carlson, B.S.Miller and R.C.McMillan.
J. chem. Phys. (USA), Vol. 34, No. 5, 1499-1500 (May, 1961).

Sodium azide irradiated with X-rays at liquid-nitrogen temperature displays a power sensitive e.s.r. spectrum of three equal line of separation 6.2 Oe. This spectrum is interpreted as N^{14} trapped in the crystal lattice.

8922 MECHANISM FOR PRODUCTION OF INTERSTITIALS IN KCl BY X RAYS AT LOW TEMPERATURES.
.Howard, S.Vosko and R.Smoluchowski.
s. Rev. (USA), Vol. 122, No. 5, 1406-8 (June 1, 1961).
Experimental evidence indicates that halogen vacancies and rstitials may be formed by X-irradiation of KCl at low tempera-es. The validity of a mechanism based on multiple ionization ends upon several factors, among them efficiency of ionisation the availability of sufficient kinetic energy to remove the inter-ial from the immediate vicinity of the vacancy. These two ditions are considered in some detail and found to be satisfied.

8923 REPRESENTATION OF THE RATE OF F-CENTRE FORMATION UNDER THE ACTION OF X-RAYS AT OM TEMPERATURE. F.Fröhlich.
Naturforsch. (Germany), Vol. 16a, No. 2, 211-13 (Feb., 1961).
German.
The rate of F-centre formation in thin NaCl and KCl crystals ler X radiation was determined from absorption measurements. e increase in concentration of F-centres is rapid at first and n decreases to a linear rate. Rate equations are given, in which rapid rise is associated with anion vacancies distributed oughout the crystal, and the linear portion with vacancies with a ferent capture cross-section localized near dislocations. ditional vacancies of the second type are formed under X radiation.
J.Franks

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

8924 VARIATION OF RESISTANCE OF A THIN METAL FILM DEPOSITED ON A DEFORMABLE SUBSTRATE.
Laniepce, A.Colombani and P.Thureau.
R. Acad. Sci. (France), Vol. 257, No. 13, 1919-21 (March 27, 1961)
French.
The relation between the deformation of the substrate and the sequent change in resistance has been established previously ostr. 21253 of 1960), the resistance being measured along a e parallel to the deformation. In this case the resistance was asured at 90° to the deformation, using films of bismuth on strates of mica or perspex. The changes were larger than se observed before, but again they were a maximum for films ut 1000 A thick.
C.Hilsum

8925 HOT ELECTRONS IN METAL FILMS: INJECTION AND COLLECTION. J.P.Spratt, R.F.Schwarz and W.M.Kane.
s. Rev. Letters (USA), Vol. 6, No. 7, 341-2 (April 1, 1961).
The tunnel effect is used to provide injection at a controlled el above the Fermi level, and an aluminium—germanium inter-e provides a collector surface barrier. The 90% collection ciency obtained implies a mean free path of 1000 A. The ucture can be used as an amplifier similar to a transistor.
M.G.Priestley

8926 TEMPERATURE COEFFICIENT OF RESISTANCE OF THIN METAL FILMS ON CERAMIC SURFACES.
chwarz.
Phys. (Germany), Vol. 162, No. 4, 402-9 (1961).
The temperature coefficients (TCR) of vacuum-deposited thin-al—film resistors were measured in vacuum, air, argon, and cone oil, and different characteristics were obtained. The istors were made by evaporating a nickel—chrome alloy chrome 80 to 20) in vacuum on to ceramic substrates to produce 00 ohms-per-square film. Measurements were made of films ch were uncoated and of films which were coated with a protec-layer of silicone monoxide in thicknesses from 5000 to 10 000 A. en measured under vacuum, the resistors displayed a TCR which lower than that obtained in air, argon, or silicone oil. In an on environment, the resistors had lower TCR characteristics they had in air or silicone oil. Even when the resistor films e protected by a 10 000 A thick layer of silicone monoxide, r TCR behaviour differed in different gas environments.

THE LAW OF WIEDEMANN AND FRANZ.
Abstr. 8890

CHANGE OF THERMAL AND ELECTRICAL CONDUCTIVITY OF FERROMAGNETICS IN A MAGNETIC FIELD. See Abstr. 9034

ANOMALY IN THE ELECTRICAL RESISTIVITY OF VANADIUM AT 245°K. See Abstr. 7735

ELECTRICAL RESISTIVITY OF ERBIUM SINGLE CRYSTALS. See Abstr. 7774

8927 THE ELECTRICAL CONDUCTIVITY OF GELATIN FILM HUMIDIFIED WITH HEAVY WATER VAPOR.
C.D.Niven.
Canad. J. Phys., Vol. 39, No. 5, 657-61 (May, 1961).
When protons were replaced by deuterium nuclei in gelatin films, by exposure of dry films in 75% relative humidities, the resistance increased very markedly.

8928 ELECTRICAL CONDUCTIVITY OF SOME COORDINATION POLYMERS. S.Kanda and S.Kawaguchi.
J. chem. Phys. (USA), Vol. 34, No. 3, 1070-1 (March, 1961).
Electrical conductivity was measured on disc specimens of compressed powders of three coordination polymers using a.c. and d.c. methods. The frequency used is not given. The polymers were: (A) 1,6-dihydroxyphenazinato-Cu (II); (B) 2,5-dihydroxy-p-benzoquinonato-Cu (II); (C) rubeanato-Cu (II). Compound C showed semiconducting properties with a resistivity of the order of 10^5 ohm cm and an activation energy of 0.2 eV. Compound A gave reproducible d.c. resistivities of the order of 10^{13} ohm cm but no reproducible results were obtained with compound B.
R.G.C.Arridge

8929 EFFECT OF PLASTIC DEFORMATION ON THE LOW-TEMPERATURE IONIC CONDUCTIVITY OF POTASSIUM CHLORIDE. B.S.H.Royce and R.Smoluchowski.
Phys. Rev. (USA), Vol. 122, No. 4, 1125-8 (May 15, 1961).
Measurements were made on the ionic conductivity of KCl in the temperature range 25°-250°C. Both "as received" crystals and specimens having up to 24% plastic deformation were examined and the activation energies for ionic motion determined. It was found that up to 4% plastic deformation produced no change in the activation energy over the "as received" specimens, whereas deformations above 10% produce a decrease of about 0.2 eV. After such deformation, structure normally present in the ln(IT) versus T^{-1} plot is absent and the decrease in activation energy can be attributed to the generation of ion vacancies not associated with divalent impurities. Measurements on a deformed and annealed specimen support this view.

8930 INVESTIGATION OF AGEING IN TRIGLYCINE. SULFATE. J.Stankowska and J.Stankowski.
Acta phys. Polon. (Poland), Vol. 19, No. 2, 217-25 (1960).
Crystals of triglycine sulphate show a constricted, or double, D/E hysteresis loop after ageing. The application of a high alternating field for a few minutes, or heating the crystal to above its Curie temperature for a short time, restores a normal hysteresis loop. An aged crystal has a lower permittivity, particularly at the Curie temperature and just above, than a "rejuvenated" crystal. The addition of small amounts of $CuSO_4$ enhances the ageing effect in so far as "rejuvenation" by an alternating field is slowed down.
K.W.Plessner

Semiconductors

8931 STUDY OF SURFACE PHENOMENA IN SEMICONDUCTORS BY THE FIELD EFFECT.
R. Pick and M. Savelli.
J. Phys. Radium (France), Vol. 21, No. 10, 743-50 (Oct., 1960).
In French.
A number of technical methods, among them the field effect, make the density of free carriers in the surface different from that in the rest of the material, observing, nevertheless, the conditions of thermodynamic microequilibrium, which validates the use of the theory of Shockley and Read recombination (1952). From the measure of conductivity variations and photoconductivity decrease in relation to the field effect, it is possible to determine the density of centres of surface recombination, their energy level, and the capture probabilities of electrons or holes by these centres.

8932 MAGNETOELECTRIC AND THERMOMAGNETOELECTRIC EFFECTS IN SEMICONDUCTORS. I.
L.Godefroy and J.Tavernier.

J. Phys. Radium (France), Vol. 21, No. 4, 249-60 (April, 1960). In French.

The electrical conductivity of a crystal in the presence of a magnetic field is investigated, by the method of the average energy gain. It is possible to express the current density in tensor from, as a function of the electric and magnetic fields, in the case of a single valley. Also, in the limit of low magnetic field strengths the resistivity and thermoelectric power tensors have been obtained (the latter includes the thermoelectric power proper, the Nernst and thermomagnetoresistance effects). The results are applied to the particular models of germanium and silicon.

8933 HEITLER–LONDON APPROACH TO ELECTRICAL CONDUCTIVITY AND APPLICATION TO d-ELECTRON CONDUCTIONS. J.Yamashita and T.Kurosawa.
J. Phys. Soc. Japan, Vol. 15, No. 5, 802-21 (May, 1960).

Conduction by the movement of an extra electron which is tightly bound to an ion in an ionic lattice is discussed. It is assumed that the wave-function of the electron is localized closely around an ion and the motion of the electron is so slow that lattice polarization is induced around the electron. Further, it is assumed that the potential in the lattice deviates slightly from a perfectly periodic arrangement owing to the existence of many impurity-ions. In these circumstances the current is connected with a hopping motion of the electron from ion to ion rather than with a translational motion of the electron in a nearly perfect lattice. In section 2 the self-trapped state of a positive hole in a polar lattice with a fluctuating potential is discussed. In section 3, a theory of the transition of the hole from ion to ion by using the non-adiabatic approximation is developed, and further in section 4, the same problem is discussed by the adiabatic approximation. In the last section the theory is compared with experiments. The electrical conduction through d-electrons in the crystals such as $Li_xNi_{1-x}O$, $LaMnO_3 + SrMnO_3$, magnetite and $CoFe_2O_4$ is regarded as a good example to which the Heitler–London conduction mechanism is applicable. The impurity conduction in germanium is discussed from a similar point of view.

8934 SCATTERING OF ELECTRONS BY PHONONS AND IMPURITIES IN SEMICONDUCTORS.
H.Reiss and A.I.Anderman.
Phys. Rev. (USA), Vol. 122, No. 4, 1135-40 (May 15, 1961).

A theory is developed for the mobility of an electron in an n-type semiconductor under the combined scattering by phonons and impurities. An attempt is made to combine the two processes in a rigorous manner by treating the effects of impurities as though due to an applied external field. Although in principle a solution for any value of τ, the phonon scattering relaxation time, should be possible, this paper only arrives at a limiting law for the mobility at small values of τ. In the region of applicability satisfactory agreement with experiment is achieved.

8935 BEHAVIOR OF HOT ELECTRONS IN MICROWAVE FIELDS. B.V.Paranjape.
Phys. Rev. (USA), Vol. 122, No. 5, 1372-5 (June 1, 1961).

A strong external electric field in a semiconductor produces hot electrons. Here the currents produced by such electrons in a microwave field are studied theoretically. Two special cases are discussed: Case A deals with a strong steady electric field on which a weak microwave field of frequency ω is super-imposed. It is found that in addition to a steady current there is an alternating current of frequency ω which leads the microwave field by a phase given by an equation derived in the paper. The phase difference is negligible at low frequency, but becomes appreciable at frequencies $\omega \cong (1/\tau_0)(1/100)$, at liquid-nitrogen temperature. Here τ_0 is the electron–phonon relaxation time of thermal electrons. (Interaction with acoustic modes only is considered). In case B, the effect of a strong microwave field is considered by itself. Here the current has a strong component of frequency ω and a weaker component of frequency 3ω. Phases similar to those in case A are found. Results for case B are valid if $1/\tau_0 > \omega > (1/\tau_0)(1/100)$ at liquid-nitrogen temperature.

8936 ELECTRON–ELECTRON SCATTERING AND TRANSPORT PHENOMENA IN NONPOLAR SEMICONDUCTORS.
J.Appel.
Phys. Rev. (USA), Vol. 122, No. 6, 1760-72 (June 15, 1961).

The effect of electron–electron scattering processes due to Coulomb forces on the transport phenomena in nonpolar isotropic solids is treated in the framework of Kohler's variation principle. By considering the conduction electrons as a Fermi–Dirac gas of noninteracting free quasi-particles, each with charge $-e$ and mass m^*, electron–electron scattering is taken into account as a small perturbation, as is electron–phonon scattering in nonpolar solids. A shielded Coulomb potential which depends on two parameters — the effective dielectric constant and the shielding constant — is used as the interaction potential. These two parameters, for small concentrations of electrons, may be assumed to independent of the distance between two electrons during a scattering process. A general qualitative result is that electron–electron scattering causes the electrical conductivity to be reduced less than the electronic heat conductivity. The conductivities and Wiedemann–Franz ratio will be reduced by an amount determined the energy dependence of that perturbation of the electron distribution which is induced by primary scattering sources such as electron–phonon scattering or electron–impurity scattering. Quantiative results for nondegenerate semiconductors are obtained in terms of the variational method. With electron–phonon and electron–ion scattering assumed in turn as the primary scattering mechanism, the influence of electron–electron scattering on the electrical conductivity, the heat conductivity, and the Seebeck coefficient is calculated as function of temperature. The results are discussed with respect to the experimental situation. The effect of electron–electron scattering on transport phenomena in metals is briefly considered. The applicability of the results obtained for isotropic semiconductors to an important class of anisotropic semiconductors is shown.

INTERACTION OF CONDUCTION ELECTRONS WITH ACOUST WAVES IN SIMPLE SEMICONDUCTORS. See Abstr. 8875

8937 ON THE INFLUENCE OF DIFFUSION AND SURFACE RECOMBINATION UPON THE G.R. NOISE SPECTRUM OF SEMICONDUCTORS. K.S.Champlin.
Physica (Netherlands), Vol. 26, No. 9, 751-60 (Sept., 1960).

Several theories of generation-recombination (GR) noise in nearly intrinsic semiconductor which consider the effects of diff sion and surface recombination are discussed. It is shown that th earlier eigenfunction treatments of Hyde and of van Vliet and van Ziel do not allow for the fact that Fourier coefficients of different spatial modes are correlated. A proper treament based on a trans mission line analogy is presented and the result is examined for th cases arising when the recombination process is: (1) volume-lim (2) surface-limited; and (3) diffusion-limited. For the diffusion-limited case, it is found that the spectrum varies as $\omega^{-3/2}$ at high frequencies; at low frequencies, the noise determined from the t over frequency is 5/6 that found for the volume- and surface-lim cases.

8938 DETERMINATION OF THE SEMICONDUCTOR SURFACE POTENTIAL UNDER A METAL CONTACT.
N.J.Harrick.
J. appl. Phys. (USA), Vol. 32, No. 4, 568-70 (April, 1961).

It is shown that, through the use of the infrared absorption technique to measure the added carrier density in a semiconducto bulk adjacent to a metal contact coupled with simultaneous measur ment of the floating potential of the contact, a reliable determinati of the semiconductor surface barrier height under the metal conta can be obtained.

CONTRIBUTION TO THE STUDY OF ELECTRODE POTENTIALS OF SEMICONDUCTORS IN SOLUTION. See Abstr. 7915

Semiconducting Materials

8939 CURRENT FLOW ACROSS GRAIN BOUNDARIES IN n-TYPE GERMANIUM. I. R.K.Mueller.
J. appl. Phys. (USA), Vol. 32, No. 4, 635-9 (April, 1961).

A theory of the current flow is given. In the temperature range where carrier generation in the space charge region can be neglected and for donor concentrations in the bulk larger than $10^{14}/cm^3$, the current is carried essentially by electrons crossing the barrier, the zero bias conductance is independent of the donor concentration and is given by $G_0 = 2.2 \times 10^8 Te^{-\phi_0/kT}$. The appare activation energy ϕ_0 is directly related to the barrier height. The current for applied voltages which are large compared to kT/q fai to saturate. The deviation for saturation is related to the density states in the boundary band. At sufficiently low temperatures the carrier generation in the space-charge region is the rate-determining process for the current flow across the boundary.

8940 CURRENT FLOW ACROSS GRAIN BOUNDARIES IN n-TYPE GERMANIUM. II. R.K.Mueller.
ppl. Phys. (USA), Vol. 32, No. 4, 640-5 (April, 1961).
The current flow was measured in the temperature range -200°K. Precisely oriented bicrystals were grown for this dy with 4°, 6°, and 25° tilt boundaries and 6° twist boundaries. e experimental data were found to be in good agreement with oretical calculations given in Pt I. The current across the ndary is mainly carried by electrons crossing the barrier, and ncreases with decreasing boundary angle. The activation energy s found to be 0.71 ± 0.01 eV for all boundaries. A lower limit $N_B \geq 10^{13}(cm^{-2}\ eV^{-1})$ was found for the density of boundary states 5° and 25° boundaries. No significant difference between tilt and st boundaries was observed.

8941 EFFECT OF FISSION SPECTRUM NEUTRONS ON n-TYPE GERMANIUM. D.Binder.
vs. Rev. (USA), Vol. 122, No. 4, 1147-8 (May 15, 1961).
The electron removal rate for n-type germanium irradiated h fission spectrum neutrons is 8 ± 1 per neutron at room tempera-e. This value is compared with the results of monoenergetic tron irradiations from 2 to 5 MeV (Abstr. 4045 of 1959). The t that the removal rate is roughly constant is explained by the stancy of the energy dissipated in elastic collisions.

8942 GENERATION—RECOMBINATION NOISE OF Ni-DOPED Ge IN THE TEMPERATURE RANGE 350°—100°K AND PTURE CROSS-SECTIONS OF Ni IN Ge.
M.Klaassen, J. Blok and H.C.Booy.
ysica (Netherlands), Vol. 27, No. 1, 48-66 (Jan., 1961).
Theory and measurements are reported for the generation-ombination noise of compensated high-resistivity p-type nickel ed germanium crystals, both in the intrinsic and extrinsic range. om the results values were obtained for the electron capture cross-tions of neutral nickel and singly ionized nickel, being 17.5×10^{-16} ^{2} and 2.2×10^{-16} cm^2 and values for the hole capture cross-tions of singly- and doubly ionized nickel, being 3.5×10^{-14} cm^2 $\geq 10^{-13}$ cm^2. For the noise-equivalent power for infrared ection values up to 10^{-9} watt are found. Finally these results were mpared with data obtained from measurements of the photo-ductivity.

8943 THE ADSORPTION OF OXYGEN GAS ON GERMANIUM AND SURFACE CONDUCTIVITY.
.Sparnaay and J.van Ruler.
ysica (Netherlands), Vol. 27, No. 2, 153-62 (Feb., 1961).
A new method is described for studying electrical surface perties of semi conductors. The method consists of resistivity asurements at oxygen pressures, ranging from 10^{-9} mm to ^{2} mm Hg, of thin germanium monocrystalline cylinders, the dia-ter of one sample varying from 1 mm to 10^{-2} mm. Thickness iations of the cylinders can be effected by "burning off" the manium at 700°C in an oxygen gas pressure of 10^{-2} mm Hg. By s method the roles played by surface conductivity and bulk con-tivity can easily be separated. Results are given for intrinsic manium and are in qualitative agreement with results obtained Handler.

8944 ON RECOMBINATION NOISE OF GERMANIUM SINGLE CRYSTALS IN THE RANGE OF EXTRINSIC MICONDUCTIVITY. M.Pilkuhn.
Naturforsch. (Germany), Vol. 16a, No. 2, 173-82 (Feb., 1961).
German.
A largely experimental investigation of noise in germanium ow 20°K. The dependence on frequency, temperature and (weak) ctric fields is studied. The results are discussed in terms of a ombination-generation mechanism involving free electrons and ized donors. P.T.Landsberg

8945 FLUCTUATIONS DURING THE FORMATION OF IMPACT IONIZATION AVALANCHES IN Ge SINGLE YSTALS BETWEEN 5° AND 10°K. M.Pilkuhn.
Naturforsch. (Germany), Vol. 16a, No. 2, 182-7 (Feb., 1961).
German.
Noise measurements show that the increase of conductivity ing breakdown is associated with a very marked increase in se. Its frequency dependence suggests recombination-generation se, and its properties are investigated. P.T.Landsberg

MOBILITY OF RADIATION-INDUCED DEFECTS IN GERMA-JM. See Abstr. 8902

8946 MEASUREMENT OF THE MEAN IONIZATION ENERGY IN SILICON FOR α AND β PARTICLES BY MEANS OF NIP JUNCTIONS. L.Koch, J.Messier and J.Valin.
C.R. Acad. Sci. (France), Vol. 250, No. 1, 74-5 (Jan. 4, 1961).
In French.
The mean ionization energy in silicon was measured for alpha-particles with energies in the range 9 to 40 MeV and for beta-particles of 277 and 660 keV. The value obtained was 3.55 ± 0.1 eV, independent of particle type or energy. I.Cooke

8947 INVESTIGATIONS ON THE DIFFUSION OF MINORITY CARRIERS FROM A POINT ON SILICON.
C.H.Champness.
Canad. J. Phys., Vol. 39, No. 5, 754-67 (May, 1961).
The field-free diffusion of minority carriers injected at a point in silicon was studied and the time from injection to the maximum of the collector signal due to the arriving carriers measured for various emitter—collector distances. Firstly, it was found that for 2 ohm-cm, 6 μsec, n-type material the time to maximum was proportional approximately to the emitter—collector spacing raised to the power 1.2 for flat surfaces and to the power 1.6 for 3- and 6-degree wedge samples. The power 1.6 was also found for a 17-degree wedge of 120 ohm-cm, 100 μsec, p-type silicon. Secondly, decay times following the maxima appeared to increase with emitter—collector spacing. No adequate two-surface theory is available but comparison with a one-surface theory revealed serious disagreements. It would appear that the results may be explained qualitatively by assuming that the effective lifetime is dependent on the excess carrier density and decreases as the emitter point is approached.

8948 SURFACE ELECTRICAL CHANGES CAUSED BY THE ADSORPTION OF HYDROGEN AND OXYGEN ON SILICON. J.T.Law.
J. appl. Phys. (USA), Vol. 32,No. 4, 600-9 (April, 1961).
Measurements of conductance, lifetime, change in contact potential with light, and contact potential were made on bombardment-cleaned silicon surfaces and during the adsorption of molecular oxygen and atomic hydrogen. In the case of oxygen adsorption, the work function increased linearly with coverage. A change of 0.35 eV was obtained in going from $\theta = 0$ to $\theta = 1$. Very small changes in the transport properties were observed. Hydrogen atoms produced an initial decrease in work function of 0.1 eV for coverages below $\theta = 0.35$. From $\theta = 0.35$ to $\theta = 1.0$ the work function was increased by 0.3 eV. The changes in the transport properties were substantial and indicated a downward movement of the energy bands at the surface by about 0.08 eV. In the clean condition, the valence band edge was 0.12—0.14 eV below the Fermi level at the surface compared to 0.36 eV in the interior. The effect of hydrogen adsorption is discussed in terms of the adsorption data previously obtained on this system.

8949 VISIBLE LIGHT EMISSION AND MICROPLASMA PHENOMENA IN SILICON P-N JUNCTION. I.
M.Kikuchi and K.Tachikawa.
J. Phys. Soc. Japan, Vol. 15, No. 5, 835-48 (May, 1960).
It was found that the microplasma spot in the p—n junction can be located by scanning small chopped light spot on the junction surface. Combining this method of location of the microplasma spot and the observation by microscope, it is concluded that the light emitting spot does not necessarily coincide with the microplasma spot. Possibility of the effect of impurities on the light-emitting phenomena is discussed briefly in connection with the recent experimental result on the visible light emission from germanium p—n junction. A simple model of p—n junction is proposed for the understanding of microplasma phenomenon.

8950 LOW FIELD MAGNETORESISTANCE EFFECT OF PLASTICALLY DEFORMED N-TYPE SILICON.
K Kamada.
J. Phys. Soc. Japan, Vol. 15, No. 6, 998-1005 (June, 1960).
Magnetoresistance, Hall effect and resistivity were measured for n-type silicon which was plastically deformed by compression, and it is found that the symmetry relation between the relaxation time tensor and effective-mass tensor is violated, although it holds in "as grown" silicon sample. It is ascribed to the presence of dislocation scattering, violating the original symmetry of relaxation time tensor of lattice scattering. Read's theory (1954) is extended, when magnetic field is parallel to dislocation line, to explain the magnetoresistance in the presence of dislocation on the basis of the spherical energy surface, and the dislocation density, the radius of space charge cylinder around the dislocation, and the fraction of dislocation sites that have accepted electrons are estimated.

8951 THE ELECTRICAL CONDUCTIVITY OF EVAPORATED LEAD SELENIDE FILMS.
H.Gobrecht, F.Niemeck and K.E.Boeters.
Z. Phys. (Germany), Vol. 162, No. 4, 337-46 (1961). In German.

Measurements are described which show the temperature dependence of the conductivity of films in presence of low partial pressures of selenium. The interaction between the selenium vapour and the lead selenide film is revealed by the reversible dependence of the conductivity on temperature and on the partial pressure of Se. The measured relationships are quantitatively understood on the following assumptions: the reactions of lead and/or selenium vacancies with selenium particles, adsorbed from the vapour phase, are limited to the surface region of the PbSe crystallites. The interior of the crystallites remains unchanged.

8952 ELECTRICAL AND OPTICAL PROPERTIES OF $CdSnAs_2$.
W.G.Spitzer, J.H.Wernick and R.Wolfe.
Solid-State Electronics (GB), Vol. 2, No. 2-3, 96-9 (March, 1961).

The electrical and optical properties of n-type $CdSnAs_2$ were investigated for samples having carrier concentrations between 1 and 3×10^{18} cm^{-3}. Resistivity and Hall coefficient measurements yielded room-temperature electron Hall mobilities between 6200 and 5500 $cm^2 V^{-1} sec^{-1}$ in this carrier concentration range. Measurements between room temperature and liquid-helium temperature showed degenerate behaviour. Above room temperature the beginning of the intrinsic range was observed with an approximate energy gap of 0.3 eV. A thermal-conductivity measurement yielded a phonon thermal conductivity of 0.071 W/cm °C. For the same carrier concentrations, the thermoelectric power range from −100 to −70 μV/°C, indicating a thermoelectric figure of merit of $\sim 10^{-4}$/°C. Room-temperature infrared reflectivity and transmission measurements were made on the same samples used to obtain the electrical data. An electron effective mass between 0.04 m_0 and 0.06 m_0 and a lattice dielectric constant of 12.1 ± 0.1 were deduced from the reflectivity data. The shift in the absorption edge with increasing carrier concentration and the free-carrier absorption yielded electron effective masses in qualitative agreement with the values obtained from the reflectivity data.

8953 ELECTRICAL PROPERTIES OF GERMANIUM SELENIDE GeSe. S.Asanabe and A.Okazaki.
J. Phys. Soc. Japan, Vol. 15, No. 6, 989-97 (June, 1960).

Experimental studies were made of electrical resistivity and Hall coefficient of stoichiometric, non-stoichiometric and impurity-doped GeSe crystals over the temperature range from 100° to 800°K. The energy gap was estimated to be nearly 1.0 eV from the slope of the resistivity curves at high temperatures. There were two ways in which hole mobility varied with temperature: one was as $T^{-2.0}$ and the other as $T^{4.3}$. The results on the low temperature Hall coefficient are qualitatively interpreted on the assumption that there are two kinds of impurity levels in GeSe, one of which is an acceptor level due to the impurity atoms common to all specimens and the other a donor level or trapping centre of holes due to germanium atoms in excess of stoichiometry. As anomalous behaviour found in the Hall coefficient is explained by the same assumption as in the case of SnSe that new acceptors are introduced into GeSe by heat-treatment at high temperatures and that these introduced acceptors are annihilated by the heat-treatment at lower temperatures.

8954 THE CHANGE IN ELECTRON MOBILITY IN INDIUM ANTIMONIDE AT LOW ELECTRIC FIELD. Y.Kanai.
J. Phys. Soc. Japan, Vol. 15, No. 5, 830-5 (May, 1960).

The change was measured by the bridge method at 77°, 201° and 297°K. At 77°K the electron mobility decreased with increasing electric field in rather pure indium antimonide, but increased in impure one. At 201° and 298°K the change in electron mobility was too small to be detected. The effect of transverse magnetic field upon the change in electron mobility was also measured. In a transverse magnetic field, the electron mobility in indium antimonide increased with increasing electric field at 77°K, while it decreased at 201°K. At 297°K the change in electron mobility in a transverse magnetic field was also too small to be measured. To explain the experimental results mentioned above, some considerations are made on the scattering mechanism of conduction electrons in indium antimonide. It is concluded that polar scattering is the most important in indium antimonide in the temperature range from 77°K to about 300°K, and also that the impurity scattering plays an important role in the samples at 77°K; the acoustic scattering makes some contribution at 210°K.

8955 GENERATION–RECOMBINATION NOISE IN p-TYPE InSb. F.M.Klaassen, J.Blok and F.J.de Hoog.
Physica (Netherlands), Vol. 27, No. 2, 185-96 (Feb., 1961).

Measurements are reported concerning the current noise spectra of p-type single crystals of InSb in the range 175°–275°K. The magnitude of these spectra is extremely small. Nevertheless values for the relaxation times of excess carriers are accurately obtained from these spectra. The temperature dependence of these times, being of the order of 10^{-8} sec, suggests a Shockley–Read recombination mechanism. If the noise spectra is compared with the theory of generation–recombination noise for such a process, good agreement is found. Finally it is proved that the noise equivalent power has a minimum for that temperature at which the Hall-constant has a maximum. Applying this to the samples for the minimum a value of 1.8×10^{-10} watt at 220°K is found.

THE DISTRIBUTION OF ELECTRON DENSITY IN INDIUM ARSENIDE. See Abstr. 7865

8956 THE PROPERTIES OF PbSe FILMS, WITH Ag DOPING IN AN ATMOSPHERE OF AIR. J.Láng.
Acta phys. chem. Szeged. (Hungary), Vol. 3, No. 1-4, 27-32 (1957). In German.

The conductivity of undoped PbSe films was measured in air and in a vacuum. The measurements in air were repeated with a foreign metal additive. It was found that the undoped film, which h brought from a vacuum into free air, became a p-type semiconductor; with increasing Ag doping the conductivity type reverte to n-type. Measurements were made of the thermoelectric power and the photosensitivity. An optimum Ag concentration was determined which would give the same photosensitivity as was attained with a film manufactured in the usual way. A.J.F

8957 ELECTRICAL CONDUCTION IN THIN FILMS OF SILVER TELLURIDE. W.M.Kane and C.Wood.
J. Electrochem. Soc. (USA), Vol. 108, No. 1, 101-2 (Jan., 1961).

When pressure contacts are applied to thin films of Ag_2Te an e.m.f. is applied to them there is a fairly rapid variation of curr with time which is associated with the growth of dendrites in a " structure, causing low-resistance paths. The activation energy the diffusion of silver into Ag_2Te is 0.6 eV in agreement with the optical energy gap. C.A.Hog

8958 THE HALL EFFECT AND RESISTIVITY OF TELLUR R.W.McKay and W.E.Gravelle.
Canad. J. Phys., Vol. 39, No. 4, 534-50 (April, 1961).

The Hall effect and resistivity of seven crystalline samples highly purified tellurium were investigated over the temperature range −190°C to +350°C. The samples were grown from zone-refined tellurium with an adaptation of the method of Tammann. The effective impurity concentrations were in the range 5×10^{-6} 5×10^{-5} at.%. The measurements were made with an a.c. metho of high sensitivity. X-ray investigations indicated that the purest sample was a single crystal, but that the others were polycrystall However, differences in the observed properties as a result of crystal structure were not large. At high temperatures pure tell rium exhibits an anomalous behaviour in its Hall effect, and three proposed explanations of this anomaly were investigated in view o the data of this research. At much lower temperatures, it was c cluded that tellurium behaved as a simple semiconductor with unique conduction and valence bands with a non-degenerate carri distribution.

8959 THE STUDY OF THE OPTICAL PROPERTIES OF CO DUCTING TIN OXIDE FILMS AND THEIR INTERPRE TATION IN TERMS OF A TENTATIVE BAND SCHEME.
T.Arai.
J. Phys. Soc. Japan, Vol. 15, No. 5, 916-27 (May, 1960).

Is concerned with an experimental investigation of the influen of free carriers on the optical absorption of SnO_2, which is an alm perfect insulator in its stoichiometric composition but can be endowed with a semi-metallic conductivity when synthesized by the spraying method. In order to investigate the problem quantitative the intrinsic absorption edges of non-conducting films of SnO_2, Sn PbO_2 and TiO_2, as well as that of the conducting tin oxide film (Nesa), were measured at room and liquid nitrogen temperatures. The systematic shift of the edge with the variation of the lattice constants of these oxides was confirmed experimentally with the exception of Nesa, in which case the edge was always found about

eV higher in energy than that of the nonconducting SnO_2 film. latter phenomenon was interpreted as the filling-up effect of ottom of the conduction band by the free carriers, in accordance the theory of Fan et al. presented for the case of InSb. With aid of the other auxiliary electrical and thermal experiments ormed, a tentative energy band scheme of the conducting tin e was proposed.

8960 MAGNETORESISTANCE OF ORIENTED GRAY TIN SINGLE CRYSTALS. O.N.Tufte and A.W.Ewald.
s. Rev. (USA), Vol. 122, No. 5, 1431-6 (June 1, 1961).
The electronic band structure of grey tin was investigate ugh magnetoresistance measurements on oriented n- and p-type le crystals at 77°, 195° and 273°K. From these measurements low-field magnetoresistance coefficients were evaluated. Mag- resistance anisotropy was observed in n-type crystals at 195 273°K, but was not observed in either n- and p-type material at K. Two possible explanations for the temperature-dependent sotropy are proposed. The observed anisotropy satisfies, in the experimental uncertainty, the symmetry condition for psoidal energy surfaces located along the [111] the directions. l and conductivity measurements on samples used in the mag- resistance study revealed a temperature-dependent mobility o greater than unity which supports the assumption that the gnetoresistance anisotropy observed in the intrinsic range should ssigned to the conduction band. Under this assumption and that sotropy of lattice scattering, a lower limit of 2.3 is found for electronic effective-mass anisotropy parameter.

miconductor Devices

8961 USE OF SHADOW ELECTRON-OPTICAL METHODS IN STUDIES OF P–N JUNCTIONS.
.Vertsner, Yu.V.Vorob'ev and L.N.Malakhov.
tverdogo Tela (USSR), Sbornik [Supplement] II, 109-12 (1959).
ussian.
Shadow electron micrographs were used to obtain the electrical ential distribution across a germanium diode surface. Increase potential applied in the blocking direction broadened the region aximum potential drop in the diode, in agreement with indepen- capacitance measurements. A.Tybulewicz

MEASUREMENT OF THE MEAN IONIZATION ENERGY IN ICON FOR α AND β PARTICLES BY MEANS OF NIP JUNCTIONS.
Abstr. 8946

8962 OPERATION OF TUNNEL-EMISSION DEVICES.
C.A.Mead.
ppl. Phys. (USA), Vol. 32, No. 4, 646-52 (April, 1961).
The operation of a new class of devices employing the principle unnel emission is discussed. It is show that a controlled elec- n source may be obtained with the use of a metal–insulator– tal diode structure where the second metal layer is very thin. riode geometry may be secured by the addition of an additional ulator and a metal collector layer. Limitations on the operating quency, current density, and current transfer ratio of such vices are discussed. Experimental results on diodes and triodes cussed and experimental results on diode and triode structures ch employ several materials are presented. Successful triodes vacuum emitters were realized with the use of Al_2O_3 insulating ns. Experiments using Ta_2O_5 are described, and the results are cussed.

8963 ON THE VARIATION OF THE TRANSPORT FACTOR OF A JUNCTION TRANSISTOR WITH INJECTED RRIER CONCENTRATION. A.N.Daw.
an J. Phys., Vol. 34, No. 1, 20-35 (Jan., 1960).
An attempt has been made to set up a general equation govern- the distribution of injected carriers in the base region of a n–p junction transistor and hence to obtain an expression for the nsport factor. Subject to certain approximations, a relation is ived giving the emitter current density as a function of the con- tration of injected carriers and with its help, the transport or is expressed explicitly in terms of the latter. The expression ritically examined in the light of recombination process both on surface and in the volume. The results are compared with those gested by previous workers. The possible effect of the presence significant electronic component of current, across the emitter- e junction on the expression for the transport factor is also con- ered. It is shown that the effect if any would be very small. An ctronic component of current however, affects the value of the current amplification factor and a categorical experimental verdict in favour of one or the other of the different possible modes of re- combination is not possible unless the so-called emitter efficiency term can be determined by independent experimental measurement.

8964 CHARACTERISTICS OF GERMANIUM P-N JUNCTION WITH IRREGULAR STRUCTURE. M.Tomono.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1223-36 (July, 1960).
A transistor was made with an imperfect emitter junction having an irregular structure, made by applying a very thin indium layer on an n-type germanium pellet, and a comparatively perfect collector junction having a regular structure. The current flowing into the imperfect emitter was divided into various components, and the voltage–current characteristics of each component was studied. Among these, particular attention was paid to the electron current component which flows through the minute area of the m–n junction existing at the irregular part of the p–n junction. From these studies the phenomena of the voltage–current characteristics of the emitter differing greatly from the Shockly Equation, the abnormally strong current dependency of the current amplification factor of the transistor, and the floating-potential of the emitter are explained.

Photoconductivity

8965 PHOTOCONDUCTION IN A HINDERED CIS-ISOMER OF β-CAROTENE AND ITS RELATION TO A THEORY OF THE VISUAL RECEPTOR PROCESS. B.Rosenberg.
J. Opt. Soc. Amer., Vol. 51, No. 2, 238-40 (Feb., 1961).
Unhindered cis-isomers of β-carotene are approximately 1000 times and the hindered cis-isomer 1 000 000 times as photo- conductive as the all-trans-isomer. It is suggested that the visual process is governed at low light intensities by the photo-conductivity, but at high intensities by photo-isomerization of visual purple molecules. R.A.Weale

8966 THE VARIATION OF SENSITIVITY OF A SELENIUM PHOTOCELL IN A MAGNETIC FIELD, AS A FUNCTION OF TEMPERATURE. J.Vincent and G.Blet.
J. Phys. Radium (France), Vol. 21, No. 10, 685-8 (Oct., 1960). In French.
The sensitivity is decreased when a magnetic field is applied in a direction parallel to the barrier-layer. This decrease is dependent on the wave-length and a maximum is observed at about $\lambda = 0.7\ \mu$: the lower the temperature the smaller the decrease.

Thermoelectric Properties

8967 SEMICONDUCTING MATERIALS FOR THERMO-ELECTRIC POWER GENERATION.
F.D.Rosi, E.F.Hockings and N.E.Lindenblad.
RCA Rev. (USA), Vol. 22, No. 1, 82-121 (March, 1961).
A general consideration of the thermoelectric properties of semiconductors suggests that (1) this class of materials can be useful in power-generating thermocouples operating at least up to 700° C, and (2) use of a sandwich-type arrangement or graded alloying in the construction of thermocouple branches will be necessary to achieve high figures of merit over a wide temperature range and, hence, high power-generating efficiencies. A large number of ternary compound semiconductors having the cubic structure were synthe- sized. Those with the rock-salt structure, such as $AgSbTe_2$, are characterized by low lattice thermal conductivities (<0.0075 W cm^{-1} deg^{-1}). The lattice thermal conductivity as a function of composition was examined in the alloy systems of $AgSbTe_2$ with PbTe, SnTe, and GeTe. The minimum in the lattice thermal conductivity for the $AgSbTe_2$–PbTe system gives an effective mean free path for phonons which is less than unit-cell dimensions. Measurements of the tem- perature dependence of thermoelectric properties of a number of solid-solution alloy systems showed that (1) solid-solution alloys of Bi_2Te_3, with Bi_2Se_3, Sb_2Te_3, and Sb_2Se_3 provided the best p- and n-type material for thermocouple operation in the temperature range 25 to 250° C, (2) the ternary compound $AgSbTe_2$ and its alloys with GeTe provided the best p-type material for the range 250 to 550° C, and (3) alloys in the PbTe–SnTe system provided the best n-type material for the range 250 to 550° C. Power-generating thermocouples, constructed in the sandwich-type arrangement of materials, pro- vided an efficiency of ~12% for operation over the temperature range 20 to 550° C (i.e., $T_H - T_C = 530°$ C). Continuous thermo- couple operation for 300 hr resulted in no significant deterioration of material properties.

8968 EFFECTS OF DOPING ADDITIONS ON THE THERMOELECTRIC PROPERTIES OF THE INTRINSIC SEMICONDUCTOR $Bi_2Te_{2.1}Se_{0.9}$. L.C.Bennett and J.R.Wiese.
J. appl. Phys. (USA), Vol. 32, No. 4, 562-4 (April, 1961).

An alloy of 70 mol % Bi_2Te_3–30 mol% Bi_2Se_3, or $Bi_2Te_{2.1}Se_{0.9}$, is the intrinsic semiconductor of the pseudobinary system Bi_2Te_3–Bi_2Se_3. This V–VI alloy was doped with lead (Group IV) and iodine (Group VII) separately and together. The effects if the dopants are analogous to those produced by Group III or Group V impurities in Group IV elemental semiconductors, the lower group impurity producing a p-type material and the higher group impurity an n-type material. Plots of the Seebeck coefficient, electrical conductivity, and thermal conductivity are given as a function of impurity concentration and show that the separate effects of the impurities are countered when the impurities are in the lattice together in the same amount. Doping was also done with silver and iodine, separately and together. The results indicate that the silver is in the lattice interstitially (lead and iodine substitutionally) and that the type material produced is dependent also on how the impurity atom enters the lattice.

8969 EFFECT OF FREEZING CONDITIONS ON THE THERMOELECTRIC PROPERTIES OF $BiSbTe_3$ CRYSTALS. G.J.Cosgrove, J.P.McHugh and W.A.Tiller.
J. appl. Phys. (USA), Vol. 32, No. 4, 621-3 (April, 1961).

The thermoelectric parameters α, $1/\rho$, and $1/(K-K_e)$ of oriented polycrystals increase as the freezing rate decreases and as the temperature gradient in the liquid at the interface increases. The effects are primarily attributed to the variation in the degree of microsegregation produced in the crystals as a function of the freezing conditions.

Dielectric Properties

8970 DIELECTRIC RELAXATION IN HIGH POLYMERS. II. VINYLIC HIGH POLYMERS. T.Tanaka and Y.Ishida.
J. Phys. Soc. Japan, Vol. 15, No. 2, 261-9 (Feb., 1960).

For Pt I see Abstr. 7684 of 1961. In vinylic high polymers, there are two absorption mechanisms, one at high temperatures and the other at low temperatures. From a general consideration, it is possible to separate the motion of the high polymer molecule into two distinct modes, rotation and vibration. The high temperature absorption is attributed to the rotational relaxation and the low temperature absorption to the vibrational relaxation. A formal relation is obtained which connects the low temperature absorption curve to the vibrational frequency spectrum.

8971 CRYSTAL STABILITY AND THE THEORY OF FERROELECTRICITY. W.Cochran.
Advances in Phys. (GB), Vol. 9, 387-423 (Oct., 1960).

The phenomenon of ferroelectricity in pseudo-cubic crystals is discussed in terms of the normal modes of vibration. It is shown that the parameters which determine the lattice vibrations of a diatomic ionic crystal may be chosen in such a way that the crystal will exhibit ferroelectric properties, and that ferroelectric or antiferroelectric transitions may be regarded as the result of an instability of the crystal for a certain normal mode of vibration. The theory is extended to apply to other cubic crystals, including barium titanate, and the concepts of "ionic polarizability" and "a polarizability catastrophe" are discussed in terms of lattice dynamics. Certain of the parameters which appear in Devonshire's phenomenological theory of ferroelectricity are found to be expressible in terms of atomic parameters. Values for the latter which are physically reasonable are found to account quite well for the dielectric properties of barium titanate and for the relative movements of the atoms which occur at the cubic-tetragonal transition. The lowest dielectric dispersion frequency is calculated to be about 3×10^{11} c/s for barium titanate, and to be a function of temperature in the cubic phase. Other predictions of the theory are discussed.

8972 FERROELECTRIC PROPERTIES OF MIXED TITANATES IN THE SYSTEM $Bi_4Ti_3O_{12}.nBaTiO_3$. P.-H.Fang, C.Robbins and F.Forrat.
C.R. Acad. Sci. (France), Vol. 252, No. 5, 683-5 (Jan. 30, 1961). In French.

Dielectric and piezoelectric measurements were made on ceramic and single-crystal specimens of $Bi_4Ti_3O_{12}.nBaTiO_3$, for n = 1 and n = 2. The Curie temperature for the n = 1 composition is 438°C, the spontaneous polarization of order 1.2 $\mu C/cm^2$. For the n = 2 composition, the Curie temperature is 410°C, the permittivity (ϵ) and Ps are of the same order as in the n = 1 composition.
L.E.Cro

8973 EFFECT OF TWO-DIMENSIONAL MECHANICAL STRESS ON THE DIELECTRIC PROPERTIES OF POLED CERAMIC BARIUM TITANATE AND LEAD ZIRCONATE TITANATE. R.F.Brown.
Canad. J. Phys., Vol. 39, No. 5, 741-53 (May, 1961).

Studies were made of the dielectric behaviour of several ferro electric ceramic materials when a two-dimensional stress was applied normal to the axis of polarization. It was shown that the di electric constant decreases and the dielectric loss increases with increasing stress, part of the change being irreversible and part reversible. Upon application of stress to a sample, the dielectric constant did not change instanteously but appeared to decrease linearly with the logarithm of time. Mechanisms are suggested fo the observed effects.

8974 DIELECTRIC PROPERTIES OF SnO_2. L.V.Deshpande and V.G.Bhide.
Nuovo Cimento (Italy), Vol. 19, No. 4, 816-17 (Feb. 16, 1961).

The permittivity as a function of temperature was measured i ceramic and compact powder samples of SnO_2. There is a permit tivity peak in the region of 25°C, and dielectric nonlinearity is ob served below this temperature. The frequency of the measuring fi is not stated, and no data on dielectric loss are given. It is suggested that SnO_2 is ferroelectric. L.E.Cro

8975 THEORETICAL STUDY ON THE PROPERTIES OF COERCIVE FIELD OF $BaTiO_3$ SINGLE CRYSTAL. R.Abe.
J. Phys. Soc. Japan, Vol. 15, No. 5, 795-801 (May, 1960).

The properties are investigated using the previous result on the domain wall motion (1958). The dependences of the coercive field on applied field, crystal thickness and temperature are discu sed. A study on the shape of hysteresis loop is made and it is co cluded that the particular shapes of the hysteresis loop such as t double hysteresis loop are caused by the effects of internal stres

8976 MOTION OF 180° DOMAIN WALLS IN $BaTiO_3$ UNDER THE APPLICATION OF A TRAIN OF VOLTAGE PULSES. R.C.Miller and A.Savage.
J. appl. Phys. (USA), Vol. 32, No. 4, 714-21 (April, 1961).

The sidewise motion of 180° domain walls in single-crystal $BaTiO_3$ was studied under the application of a train of voltage pul Measurements of the sidewise wall velocity as a function of the pulse amplitude, pulse width, and pulse repetition rate can be explained in terms of a surface layer model (Abstr. 1699 of 1959) f $BaTiO_3$. These data constitute the first experimental verification of some of the important phenomena consequent on the model. Th model assumes that a surface charge density of $2P_S$, where P_S is the spontaneous polarization, is deposited immediately behind an advancing 180° domain boundary on the interface between the bulk ferroelectric material and the anomalous surface layer. This charge distribution gives rise to an electric field E_b' in the bulk of the material with a component opposite in direction to the field applied to move the wall. It is found that relaxation of E_b' begins about 0.3 msec and continues for times in excess of 1 sec. This relaxation is not due to a simple, single time-constant mechanis Any fast relaxation, if present, must take place in times less than 1 μsec. After a 180° wall is at rest sufficiently long so that relax tion of E_b' has occurred, application of an external applied field results in a wall velocity which depends on the magnitude of the w displacement. In particular, the wall velocity decreases (due to F which increases) with increasing wall displacement. Analyses of the data show that the lateral or sidewise range of the field from the elements of charge which give rise to E_b' is of the order of 2000 A so that once the wall has moved this distance, the effect o E_b' at the wall, and hence the wall velocity, becomes constant. W thin crystals in the absence of an external applied field, E_b' give rise to wall displacements of the order of 100 A in a direction opposite to that of the wall motion which produced E_b'. The decrease in wall velocity observed when the wall displacement pe pulse is of the order of a unit cell is consistent with a nucleation controlled mechanism proposed earlier for the wall motion. Puls data on crystals with different impurity concentrations and electr materials show that the relaxation of E_b' and the lateral range r, and hence the surface layers inferred from these data, are not markedly dependent on these parameters. Other data on the d.c.

l velocity indicate that for a velocity of 10^{-3} cm/sec, the ential drop across the surface layer is 1.0 ± 0.1 V, and that it ndependent of the crystal dopings and the electrode materials ed. These data indicate that the average field in the bulk uired for a given wall velocity is not a constant independent of type of electrode or the impurity concentration. The approxi- e constancy of the measured characteristics of the surface ers makes the dependence of the wall velocity on the impurity tent and the electrode material difficult to explain in terms of model considered.

INFLUENCE OF A STATIC ELECTRIC FIELD ON SITRONIUM FORMATION IN POLYMERS. See Abstr. 8901

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

8977 INFRARED OPTICAL CONSTANTS OF NaCl.
J.Neuberger and R.D.Hatcher.
hem. Phys. (USA), Vol. 34, No. 5, 1733-43 (May, 1961).
The infrared optical constants of NaCl are calculated by applying extended form of the Born and Blackman anharmonic potential ory to the Kellerman model of the NaCl crystal. A damping tor is derived which depends on the amplitudes and frequencies he characteristic modes as well as on the frequency of the ident radiation. By a numerical sampling of wave vector space, damping factor and the resultant optical constants are cal- ated in the range 25μ–500μ. The theory predicts a subsidiary orption maximum near 100μ which agrees with recent experi- ntal measurements. The frequency distribution function of NaCl lso given.

8978 OPTICAL CONSTANTS OF GERMANIUM IN THE REGION 0-27 eV.
P.Rustgi, J.S.Nodvik and G.L.Weissler.
ys. Rev. (USA), Vol. 122, No. 4, 1131-4 (May 15, 1961).
The reflectivity R was measured for Ge crystal over the rgy range 7.6-18.0 eV and the transmissivity T for an evaporated film over the range 16.6-27.4 eV. The reflectivity data near rmal incidence, combined with existing data at lower energies, re used in the Kramers–Krönig dispersion relation to evaluate index of refraction n and extinction coefficient k of Ge over the ge 0-18 eV. Electron characteristic losses are predicted at and 15 eV, consistent with those observed at 11 and 16 eV. The sma frequency of bulk Ge as determined by the optical data is = 10 eV.

8979 OPTICAL PROPERTIES OF SYNTHETIC QUARTZ.
M.Laikin.
Opt. Soc. Amer., Vol. 51, No. 2, 238 (Feb., 1961).
The index of refraction of crystal quartz for the ordinary ray measured over the range 159-3489 mμ. Quoted values are urate to 6×10^{-5}. A comparison with synthetic quartz shows erences of index of less than 10^{-5}. A transmission and reflection ve for the synthetic material is given. R.W.Fish

8980 FARADAY EFFECT FOR DIRECT MAGNETO-OPTICAL TRANSITIONS IN GERMANIUM.
uffczynski.
c. Phys. Soc. (GB), Vol. 77, Pt 5, 1042-5 (May, 1961).
The effect due to the interband transitions is calculated. The ct transitions from the uppermost Landau levels of the two light ladders and two heavy hole ladders are considered. The gnitude of the effect depends sensitively on the effective masses he levels in the presence of the magnetic field.

8981 REFLECTANCE SPECTRA OF THE COPPER–BISMUTH ALLOY SYSTEM.
ratny, J.J.Kokalas and F.Gugliotta.
pt. Soc. Amer., Vol. 51, No. 6, 644-7 (June, 1961).
The spectra of the copper–bismuth alloy system were investi- d in the spectral region 0.3–24 μ. The spectra are discussed in ns of the band structure of the metals, the occurrence of surface s, and solidification processes.

8982 EFFECT OF TEMPERATURE AND DOPING ON THE REFLECTIVITY OF GERMANIUM IN THE FUNDAMENTAL ABSORPTION REGION. M.Cardona and H.S.Sommers, Jr.
Phys. Rev. (USA), Vol. 122, No. 5, 1382-8 (June 1, 1961).
The 2.1 and 4.4 eV peaks in the reflectivity spectrum of germanium were studied as a function of temperature and doping. The temperature coefficient of the 2.1 eV peak is -4.2×10^{-4} eV/deg K, that of the 4.4 eV peak -1.8×10^{-4} eV/deg K. Large donor concentrations give a decrease in the energy gap at the zone boundary in the [111] direction which is nearly the same as the shrinkage of the thermal gap. No shift with doping of the 4.4 eV peak was detected. The spin–orbit splitting of the valence band at the L_3' point in the zone boundary was found to be 0.18 eV.

THE STUDY OF THE OPTICAL PROPERTIES OF CONDUCTING TIN OXIDE FILMS. See Abstr. 8959

8983 THE ABSORPTION AND FLUORESCENCE SPECTRA OF NAPHTHACENE MOLECULES IN ANTHRACENE CRYSTAL. N.K.Choudhury and S.C.Ganguly.
Proc. Roy. Soc. A (GB), Vol. 259, 419-23 (Dec. 29, 1960).
Measurements were made of the absorption coefficients and fluorescence intensities of naphthacene molecules for the a and b crystal axis directions for flakes of anthracene containing naphthacene, and from these the polarization ratios were obtained. While the ratios for fluorescence approach the values calculated for the oriented gas model, those for absorption are very much lower and this is interpreted as due to mixing of states in the absorption process. It is further concluded that the energy transfer through the crystal is partly by exciton mechanism and partly by quantum mechanical collision.

8984 THE STATE OF THE Nd^{3+} ION AS DERIVED FROM THE ABSORPTION AND FLUORESCENCE SPECTRA OF $NdCl_3$ AND THEIR ZEEMAN EFFECTS.
E.H.Carlson and G.H.Dieke.
J. chem. Phys. (USA), Vol. 34, No. 5, 1602-9 (May, 1961).
The absorption and fluorescence spectra of Nd^{3+} in $NdCl_3$ diluted by $LaCl_3$ were examined with their Zeeman effect at 4.2° and less completely also at 77° K. The empirical energy-level diagram is complete up to 28 000 cm^{-1} except for the location of the ^2K term. Crystal Stark splittings, magnetic properties, and intensities are compared to calculated values obtained from an intermediate coupling calculation of the $4f^3$ configuration.

8985 ABSORPTION SPECTRUM OF PHOTOCHEMICALLY COLORED SILVER HALIDES. F.Moser.
J. Opt. Soc. Amer., Vol. 51, No. 6, 603-8 (June, 1961).
The first section reviews the work of Kirillov and co-workers [Trudy Odesskojo Gosudarstvennojo Universiteta, Fizika, 148, 15 (1958)] in which they have reported the existence of a pronounced fine structure in the absorption spectrum of weakly coloured emulsion layers and a variety of other silver-containing systems. These authors conclude that this fine structure is characteristic of small aggregates of silver. The second section of the present paper summarizes attempts to observe this fine structure in the spectrum of exposed Lippmann emulsions and in silver hydrosols. No structure has been observed. These results indicate that the absorption spectrum of small aggregates of silver does not necessarily exhibit the general features reported by Kirillov.

8986 EFFECT OF PRESSURE ON THE ABSORPTION EDGES OF SOME III–V, II–VI, AND I–VII COMPOUNDS.
A.L.Edwards and H.G.Drickamer.
Phys. Rev. (USA), Vol. 122, No. 4, 1149-57 (May 15, 1961).
The effect of pressure to 160 kilobars was measured on the absorption edges of the III–V compounds AlSb, GaSb, InP, and InAs, the II–VI compounds CdS, CdSe, and CdTe, and the I–VII compounds CuCl, CuBr, and CuI. It is possible to discuss the band structure of the III–V compounds with reasonable assurance relative to known group IV and III–V structures. For the II–VI and I–VII compounds, ionic and other effects must be important. A number of new phase transitions were noted at high pressure. For CuCl and CuBr the T–P curves of some of these transitions were established.

8987 CRYSTAL SPECTRA OF METAL COORDINATION COMPOUNDS. IV. BIS-ACETYLACETONATO-COPPER (II).
J.Ferguson.
J. chem. Phys. (USA), Vol. 34, No. 5, 1609-13 (May, 1961).
For Pt III, see Abstr. 5047 of 1961. The polarized crystal absorption spectrum was measured with light incident on three different crystal faces. Four absorption bands were found and a consist-

ent analysis made in terms of a strong rhombic (D_{2h}) field from the ligands. The symmetries of the ground and excited states are not those predicted on the basis of simple crystal field theory and it is suggested that strong metal-ligand π bonding will account for the observed order of states. The slight differences between the positions of the bands in the crystal and in chloroform are accounted for by weak intermolecular interactions between adjacent molecules in the crystal.

8988 MAGNETIC PROPERTIES AND OPTICAL ABSORPTION SPECTRUM OF K_2ReCl_6. J.C.Eisenstein.
J. chem. Phys. (USA), Vol. 34, No. 5, 1628-48 (May, 1961).

A phenomenological theory of certain physical properties of the $(ReCl_6)^{2-}$ complex ion is presented. The ion can be described in terms of a set of parameters which includes the strength of the octahedral ligand field, the Coulomb integrals, the spin–orbit coupling constant and the orbital reduction factors. The interaction matrices for the three-electron system are given in algebraic form. With an appropriate choice of the parameters the eignevalues of these matrices are in fair agreement with the observed energy levels of the system. The effect of a departure from strict octahedral symmetry is discussed. The matrix elements of the magnetic moment operator are also given in algebraic form and then used in a calculation of the susceptibility. The discrepancy between theory and experiment is attributed to a superexchange interaction which leads, at sufficiently low temperatures, to antiferromagnetism of the compound. Finally, the results of paramagnetic resonance experiments on K_2ReCl_6 are considered.

8989 ULTRAVIOLET ABSORPTION OF THE MIXED SYSTEM KCl–KBr. H.Mahr.
Phys. Rev. (USA), Vol. 122, No. 5, 1464-8 (June 1, 1961).

The ultraviolet absorption of thin evaporated layers and the edge absorption of single crystals of the mixed system KCl–KBr were measured at room temperature in the photon energy range from 6-11 eV. In the thin layers, both the Cl^- and the Br^- absorption bands are present in the mixtures and their heights depend on the relative concentrations of the two ions. The energy values of the bands generally shift with composition, although in contrast to all the other bands, the high-energy KBr band shifts very little. The results obtained for the low-energy absorption bands can be described by a simple semiclassical electron transfer model. The behaviour of the high-energy KBr band is discussed.

8990 OPTICAL ABSORPTION OF CESIUM HALIDES WITH EXCESS HALOGEN.
G.Jacobs, L.Fiermans and F.van de Wiele.
Physica (Netherlands), Vol. 27, No. 1, 144-8 (Jan., 1961).

X-rayed CsBr crystals show an absorption band at 275 mμ. As this band could be attributed to V-type centres, the optical absorption of additively coloured CsBr and CsI crystals with excess halogen was studied. It is not clear whether we are dealing with real V-type centres, or with a solution of the halogen in the crystal.

8991 THE TEMPERATURE DEPENDENCE OF THE SHORT-WAVE ABSORPTION EDGE OF MgO IN THE INFRARED. R.Groth.
Ann. Phys. (Germany), Vol. 6, No. 5-6, 328-44 (1960). In German.

The absorption coefficient (α) curves for λ = 5-10 μ were determined at t = 20-1500° C. At higher temperatures the absorption coefficient increased linearly with t and extrapolation to 0° K gave a non-zero value of α. Interpretation in accordance with the theory of Born and Huang indicates that the total absorption has contributions from both the sum and the difference of transitions in two modes of lattice vibrations. G.F.Lothian

8992 INFRARED ABSORPTION SPECTRA OF DIAMONDS OF DIFFERENT TYPES. S.C.Sirkar.
Indian J Phys., Vol. 34, No. 1, 13-19 (Jan., 1960).

The i.r. absorption spectra of ten specimens of which the fluorescence and absorption spectra had been previously studied were investigated using a Perkin–Elmer Model 21 spectrophotometer. Two of the diamonds, transparent upto about 2300 A in the u.v. region and producing no fluorescence band at 4156 A, exhibited only very weak i.r. absorption in different regions, while the other specimens showed some or all the absorption bands reported by previous workers. It was concluded that these i.r. band's with the exception of the 1360 cm^{-1} band, are due to impurities and are not produced by characteristic vibrations of the diamond lattice. The 1360 cm^{-1} band was assigned to the vibration in those portions of the lattice which are under strain due to presence of impurities.

8993 NEAR-INFRARED ABSORPTION SPECTRUM OF SOLID METHANE AT THE λ POINT. J.A.Glasel.
J. chem. Phys. (USA), Vol. 34, No. 5, 1649-52 (May, 1961).

Observations on the near-infrared absorption spectrum of solid methane in the region of $\nu_1 + \nu_4$ and $\nu_3 + \nu_4$ over a temperatu range of 6° to 33° K are presented and discussed. There is no evidence of molecular rotation, and the observations are shown to lead to an interpretation involving an order–disorder transition. Approximate f numbers of the transitions are measured.

8994 INFRARED SPECTRA OF ALKALI METAL AZIDE CRYSTALS. H.A.Papazian.
J. chem. Phys. (USA), Vol. 34, No. 5, 1614-16 (May, 1961).

The infrared spectra of CsN_3, RbN_3, KN_3, and NaN_3 crystals were recorded at room temperature and at liquid-nitrogen temperature. Considerable anharmonicity in the fundamentals of N_3^- and combinations with lattice modes was observed. Splitting of the doubly degenerate ν_2 was observed. Discrepancies between the several reported values of ν_3 are discussed.

8995 THE INFRARED SPECTRA OF AQUEOUS BORON MINERALS, HOWLITH AND DANBURITE IN THE REGION FROM 400 TO 1800 cm^{-1}. H.Moenke.
Jenaer Jahbruch (Germany), 1960 I, 191-215. In German.

Transmission measurements were made using the KBr pellet method on about 18 mineral specimens. Transmission curves and tables showing absorption maxima are given. The minerals can be differentiated by this method. G.F.Lothia

8996 SPECTROSCOPIC STUDY OF THE YTTERBIUM–IRON EXCHANGE INTERACTION IN YTTERBIUM IRON GARNET. K.A.Wickersheim.
Phys. Rev. (USA), Vol. 122, No. 5, 1376-81 (June 1, 1961).

The exchange splittings of the ytterbium ground-state doublet and of an excited state ($J = \frac{5}{2}$) doublet were determined from spectroscopic studies of single-crystalline, ytterbium iron garnet. The splittings were observed at 77° K as a function of the orientation of the magnetization of the crystal. The splittings exhibit the functional form of the g-tensor of a two-level system. The principal values of the splittings (referred to local x, y, z axes) are, for the ground-state doublet, 11.6, 25.7 and 29.9 cm^{-1} and, for the excited state doublet, 15.9, 5.8 and 29.9 cm^{-1}. From the ground state splitting, using g values for ytterbium in yttrium gallium garnet, the approximate principal values of the exchange field (assumed to act on the ytterbium spin magnetic moment only) were found to be 349 000, 611 000 and 678 000 G. The principal values of the effective field (assumed to act on the total magnetic moment) are one fourth as large as those of the exchange field. On the basis of the ground state exchange splitting, calculations of various macroscopic properties of ytterbium iron garnet, as a function of orientation of magnetization and of temperature, have been carried out by others. The calculated properties are in generally good agreement with experiment, but the sharp, low-temperature magnetic anisotropy anomalies which were observed in ytterbium-doped yttrium iron garnet are not explained by the spectroscopic data.

OPTICAL PROPERTIES OF $CdSnAs_2$. See Abstr. 8952

8997 AN X-RAY ABSORPTION PROCESS IN IONIC CRYSTALS. P.E.Best and J.L.Robins.
Proc. Phys. Soc. (GB), Vol. 77, Pt 5, 1046-9 (May, 1961).

Two peaks at 9.8 eV and 13.9 eV, in the observed characteristic electron energy loss spectrum of potassium chloride, were identified as being due to the excitation of surface and volume plasma oscillations respectively. The first two maxima of the K X-ray absorption spectrum of the chloride ion in potassium chloride are of energy 9.8 eV and 13.6 eV greater than the valence → K emission line, and it is proposed that these two peaks are caused by the transition K → valence plus excitation of some mode of plasma oscillation. It is suggested that corresponding peaks in the X-ray absorption spectra of other ionic crystals have the same origin.

8998 INFRARED EMISSION SPECTRA OF QUARTZ. T.Wentink, Jr and W.G.Planet, Jr.
J. Opt. Soc. Amer., Vol. 51, No. 6, 595-600 (June, 1961).

The spectra were taken every 0.2 sec on the materials heated under ablating conditions in an arc wind tunnel. Surface temperatures near 2400° K are deduced and emissivity values for the corresponding highly viscous state are estimated. The enhancement of the emissivity at wavelengths below 4.5 μ by the use of "white" quartz is reported. Details of the scanning spectrometer (sweep rate 3.5 μ/0.2 sec) and application to measurement of surface temperatures are presented.

8999 INFRARED TRANSMITTANCE AND EMITTANCE OF POLYTETRAFLUOROETHYLENE.
entink, Jr and W.G.Planet, Jr.
pt. Soc. Amer., Vol. 51, No. 6, 601-2 (June, 1961).
The infrared absorption spectrum of polytetrafluoroethylene at K from 2 to 15 μ and the surface-emission spectrum at a imum temperature of 700°K from 2.7 to 6.0 μ are reported. responding absorption coefficients and emissivity are discussed. emissivity varies with wavelength in accordance with the rption, as expected, so that assignment of a colour temperature escription of the hot surface as a greybody are not valid.

uminescence

9000 THE QUANTITATIVE INTERPRETATION OF LUMINESCENT PROPERTIES OF Cu-ACTIVATED LCIUM ORTHOPHOSPHATE. Y.Uehara.
Phys. Soc. Japan, Vol. 15, No. 4, 612-29 (April, 1960).
A fundamental equation of luminescence which can explain ious luminescent properties of nonphotoconducting phosphors ler excitation by ultraviolet illumination of constant intensity at rmal equilibrium is formulated. According to this equation, ious characteristics of Cu-activated β-calcium orthophosphate ed in a reducing atmosphere, such as temperature dependence of quantum efficiency of fluorescence, thermoluminescence and mulation or that of the quantum light-sum and fluorescent inten-y, the build-up and fatigue of luminescence, the recovery from fatigue of luminescence, and the relation between the fluorescent ensity and concentration of activators were calculated in detail using an energy state model involving the ground, emitting, pping and quenching states. Furthermore the detailed experi-ntal results on the build-up of afterglow together with its oretical results are described. A good agreement between the culated and observed results was obtained.

9001 LUMINESCENCE EXCITATION SPECTRUM OF DIAMOND NEAR THE FUNDAMENTAL ABSORPTION GE. J.C.Male.
c. Phys. Soc. (GB), Vol. 77, Pt 4, 869-75 (April, 1961).
Spectra were obtained, at room temperature, for 13 natural nonds comprising six of type I, three of type IIa, three of ermediate" type and a single, semiconducting diamond. Excita-peaks, corresponding in detail to the well-known absorption ds at 5.250 eV, 5.363 eV and 5.391 eV were detected in all ept the semiconducting crystal, and indications of further ucture in this energy region were seen. In the region of damental optical absorption, broad excitation bands with maxima .51 eV, 5.56 eV and 5.73 eV occur in all but the semiconducting stal. The semiconducting diamond showed unique features sistent with the presence of an acceptor level within 0.35 eV of valence band. The luminescence emission spectrum appears to ndependent of the quantum energy of the exciting radiation. minescence decay times of 10 milliseconds were generally found for the semiconducting diamond, the decay time was six onds.

9002 EXCITATION AND DETERIORATION OF THE LUMINESCENCE OF $CaWO_4$ AND Zn:Ag BY MEANS OF S. G.Döll.
Phys. (Germany), Vol. 162, No. 2, 215-28 (1961). In German.
The luminescence-reponse of ZnS:Ag and $CaWO_4$ to ion bombard-nt and the deterioration of luminescence under prolonged irradi-on were determined as a function of ion energy E, ion mass M_i and m density I. The variation of light output with ion energy is of form $J_0 = C_J.(E - E_0)^n$, with n = 2 (ZnS:Ag) or lower values WO_4). The luminescence response to ions of various mass was nd to decrease generally with growing mass, but to be nearly stant to ions of middle atomic weight (ZnS:Ag). The luminescence ciency, caused by ions of energy greater than 5 keV, is indepen-t of beam density within the whole range studied here (maximum 10^{-7} A cm^{-2}), but it diminishes for E = 5 keV for values of I ve 6×10^{-8} A cm^{-2}. The deterioration effect increases, except he case of He^+-ions (the lightest ions used) with ion energy. It increases by substituting Ne^+ for He^+ ions, but remains nearly pendent of mass ($CaWO_4$) or diminishes with increasing ion mass S:Ag), if the ions are heavier than Ne^+ ions. Increasing beam sity leads to a reduced deterioration of ZnS:Ag luminescence, has no influence on that of $CaWO_4$.

9003 OPTICAL PROPERTIES AND STRUCTURE OF LUMINESCENT PRODUCTS BASED ON CALCIUM FLUORIDE AND ANTIMONY OXIDE.
F.Gaume, R.Bernard, P.Dupont and J.Janin.
C.R. Acad. Sci. (France), Vol. 252, No. 4, 544-6 (Jan. 23, 1961).
In French.
Mixtures of CaF_2 and Sb_2O_3 fired at 1000°C yield materials with the cubic fluoromeite structure, accompanied by excess of CaF_2 or Sb_2O_4. The maximum yellow fluorescence arises from an original mixture containing 38% Sb_2O_3. There are differences in the excitation and diffuse reflection spectra between these products and fluoromeite. S.T.Henderson

9004 PHOTOLUMINESCENCE NEAR THE FUNDAMENTAL ABSORPTION EDGE OF CdSe-CdS MIXED CRYSTALS.
E.F.Gross and V.V.Sobolev.
Dokl. Akad. Nauk SSSR, Vol. 133, No. 1, 56-9 (July 1, 1961).
In Russian.
"Edge" photoluminescence spectra (S), at dispersions up to 13 A/mm, were studied for CdSe single crystals, and for coarsely polycrystalline layers of CdSe, CdS, and their solid solutions (~ 0.2 mm thick). S showed a group of narrow equidistant bands (B) and, at shorter wavelengths, a group of narrow lines (L). For CdSe crystals at 4.2°K B consisted of two systems, mutually displaced by 80-100 cm^{-1}, with peak separations of 213 cm^{-1} (cf. 300 cm^{-1} quoted for CdS). The peaks could be resolved into several lines ~ 26 cm^{-1} apart. The strongest lines in L coincided with absorption lines (see Abstr. 13692 of 1960). For the layers at 4.2°K, the lines of shortest wavelength in L were at 4804, 4809, 4813 A for pure CdS, 6660, 6700, 6750 A for pure CdSe, and coincided with absorption lines. For most specimens a triplet structure was found for B (component separations ~ 90 cm^{-1} and ~ 26 cm^{-1} for CdS and CdSe) instead of the doublet in single crystals; however doublet structure was observed with some solid solution specimens. B and L otherwise tended to alter smoothly with composition. B and L structures at 77.3°K are briefly discussed. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 4, 735-8 (Jan.-Feb., 1961)].
C.H.L.Goodman

9005 THE PREPARATION OF FLUORESCENT GERMANIA.
J.F.Sarver and F.A.Hummel.
J. Electrochem. Soc. (USA), Vol. 108, No. 2, 195-6 (Feb., 1961).
Prescriptions are described for the preparation of the stable fluorescent rutile form of GeO_2 from the metastable α-quartz structure. The fluorescence excited by 16 kV electrons and by 2537 A u.v. radiation was examined and found to be considerably weaker than the emission from Zn_2SiO_4:Mn. The emission band was contained between 4400 and 7200 A with a peak at 5370 or 5380 A. The form of the fluorescence decay curve indicated a single excited state lifetime of 0.137 msec. It is suggested that the fluorescence does not occur at impurities, but may be connected with the presence of anion vacancies similar to those found in TiO_2. P.J.Dean

9006 GREEN PHOTOLUMINESCENCE FROM MAGNESIUM FLUOROGERMANATE AT DIFFERENT TEMPERATURES.
G.Déjardin, J.Janin and J.C.Souillat.
C.R. Acad. Sci. (France), Vol. 251, No. 23, 2678-80 (Dec. 5, 1960).
In French.
The photoluminescence of high purity magnesium fluorogermanate, stimulated by 3650 A radiation, was compared with that of doped material which contained 0.05 to 0.4% Mn^{4+}. Red bands, characteristic of Mn^{4+}, and a broad green band were observed. The intensity of the latter decreased rapidly with the concentration of Mn^{4+}, but was unaffected by changes in ambient gas. The green band intensity was comparable to that of the red bands between −180°C and +18°C and was reduced to zero between +100°C and +300°C. The red band intensities increased regularly from −180°C to +300°C. Two excitation bands were observed for the green band radiation at 2550 A and 3600 A. For the doped samples, diffuse reflection spectra contained bands (characteristics of Mn^{4+}) at 2800 A and 4200 A. The absorption leading to green emission was very weak, indicating a low density of centres or small transition probability. Further work is in progress to elucidate the nature of the green band centre.
P.J.Dean

9007 STRAIN-INDUCED EFFECTS ON THE DEGENERATE SPECTRAL LINE OF CHROMIUM IN MgO CRYSTALS.
A.L.Schawlow, A.H.Piksis and S.Sugano.
Phys. Rev. (USA), Vol. 122, No. 5, 1469-76 (June 1, 1961).
When uniaxial pressure is applied along [100], [110], and [111] directions to MgO crystals with chromium impurities, both a splitting and a shift of the purely cubic field fluorescence line at

14 319 cm^{-1} are observed. The splitting is ascribed to the removal of the degeneracy associated with the $t_2^5\ ^2E$ excited state by the strain-induced low-symmetry crystal fields. A theoretical calculation of the splitting, assuming a point-charge model, gives a surprisingly good agreement with the experiment. The shift is clearly due to the isotropic part of the strain-induced crystal fields, and a simple consideration shows that the observed red shift is caused by the strain-induced change of the Coulomb interaction between the t_2 electrons. Finally, limitations of the point-charge model adopted here are discussed.

9008 GRAIN BOUNDARY LUMINESCENCE IN AN ALKALI HALIDE PHOSPHOR. R.Illingworth.
Phil. Mag. (GB), Vol. 6, 25-6 (Jan., 1961).

Polycrystalline KBr containing 1% $SnBr_2$, grown from a melt and excited by short ultraviolet, shows a diffuse luminescent pattern corresponding to grain boundaries in the top surface of the specimen. The Sn activator is concentrated at these boundaries.
S.T.Henderson

9009 THE LUMINESCENT DECAY OF VARIOUS CRYSTALS FOR PARTICLES OF DIFFERENT IONIZATION DENSITY. J.C.Robertson and J.G.Lynch.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 751-6 (March, 1961).

Measurements of the decay in LiI(Eu), NaI(Tl), KI(Tl), CsBr(Tl) and three CsI crystals of varying thallium concentration were made for particles with different ionization densities. The decay time of the luminescence is found to depend on the average ionization density ρ. In all cases except LiI(Eu) two components are found in the decay. The dependence of the decay times and efficiency, the relative voltage pulse height per unit energy, on thallium concentration for different particles was studied in CsI. The ratio τ_e'/τ_α was found to increase with the average Z of the crystal where τ_e' and τ_α' are the average decay times for electrons and alpha particles respectively.

9010 THE DECAY OF THE LUMINESCENCE OF NaI AND CsI ACTIVATED WITH Tl UNDER EXCITATION WITH ULTRAVIOLET LIGHT. P.Brauer, H.Blume and H.J.Huber.
Z. Naturforsch. (Germany), Vol. 16a, No. 2, 213-14 (Feb., 1961). In German.

The decay after ultraviolet excitation is unaffected by excitation density and is faster than for excitation by α, β, or γ-rays and other energetic particles. Probably the centres are excited directly by ultraviolet, but by secondary electrons in the other cases.
S.T.Henderson

ABSORPTION AND FLUORESCENCE SPECTRA OF NAPHTHACENE MOLECULES IN ANTHRACENE CRYSTAL.
See Abstr. 8983

MEASUREMENT OF NANOSECOND SCINTILLATION DECAY TIMES. See Abstr. 8227

FLUORESCENT RESPONSE OF SCINTILLATION CRYSTALS TO HEAVY IONS. See Abstr. 8404

9011 INVESTIGATIONS ON THE STEEPNESS OF LUMINANCE–VOLTAGE CURVES OF ELECTRO-LUMINESCENT ZnS PHOSPHORS. C.Fritzsche.
Jenaer Jahrbuch (Germany), 1960 I, 309-19. In German.

Phosphors were tested in a castor oil cell at 800 c/s. The slope of the luminance–voltage curve $B = a_1 \exp(-b_1/V^{1/2})$ changes with the concentration of phosphor in the layer, while with increase of Cu in the material the B–V relation changes towards $B = a_2 V \exp(-b_2/V^{1/2})$. Increase of Cl in the phosphor increases the value of b_1. When separate emission bands are measured, the values of b may increase or decrease with wavelength of the band, and reasons for this are discussed.
S.T.Henderson

9012 ELECTROLUMINESCENCE AND CRYSTAL STRUCTURE IN THE ALLOYS SYSTEM ZnS–CdS.
D.W.G.Ballentyne and B.Ray.
Physica (Netherlands), Vol. 27, No. 3, 337-41 (March, 1961).

Alloys were annealed to obtain equilibrium conditions. It was confirmed that solid solution occurs at all compositions and the variation of lattice parameters with concentration has been determined. The effect of adding excess (<1%) Cu has been investigated with special reference to the appearance of electroluminescence in alloys of this type, and to the structure.

MAGNETIC PROPERTIES OF SOLIDS

9013 MAGNETIC PROPERTIES OF IRON PHOSPHIDE Fe_2P. S.Chiba.
J. Phys. Soc. Japan, Vol. 15, No. 4, 581-5 (April, 1960).

It was found by means of a newly designed apparatus for the measurement of magnetization that the extrapolated saturation magnetization at absolute zero of temperature reaches 66.3 gauss per gram of iron, corresponding to a spin moment of 0.85 ± 0.02 Bohr magneton per iron atom. The ferromagnetic Curie point is at 306°K. The Curie–Weiss law holds up to 900°K with the paramagnetic Curie point 478°K and the effective magneton number 3.2 ± 0.2.

SOLUTION OF THE SCHROEDINGER EQUATION IN A CONSTANT MAGNETIC FIELD AND DIAMAGNETISM
See Abstr. 8055

9014 OBSERVATION OF DE HAAS–VAN ALPHEN TYPE OSCILLATION IN THE ACOUSTOMAGNETIC ATTENUATION OF ZINC. D.F.Gibbons.
Phil. Mag. (GB), Vol. 6, 445-7 (March, 1961).

Oscillations were observed only for specific modes and direc of propagation with a field strength greater than 20.0 kOe. Period in $\Delta(1/H)$ of 2.1 ± 0.05, 0.3 ± 0.1 and 7.0 ± 1.0 × 10^{-6} Oe^{-1} were measured; these data are in excellent agreement with the magneti data of Verkin and Dmitrenko (1955).

9015 MAGNETIC SUSCEPTIBILITY OF CEROUS MAGNESIUM NITRATE. R.P.Hudson and W.R.Hosler
Phys. Rev. (USA), Vol. 122, No. 5, 1417-20 (June 1, 1961).

The most striking features of the behaviour of cerous magnesium nitrate at liquid helium temperatures—extremely anisotrop susceptibility with $g_{11} \cong 0$, a large temperature-independent term in $\chi_\perp$, the spin–lattice relaxation time varying as the twelfth or higher power of T in the region of 2°K—have until very recently received no detailed explanation. A measurement of $\chi_\perp$ between 4° and 300°K was undertaken to elicit information on the energies of the excited doublets within the $J = \frac{5}{2}$ ground multiplet, and thus to provide a guide for the reassessment of the crystal field paramet δ_1 and δ_2 were found to be 30 and (roughly) 200 cm^{-1}, respectively in contrast to the 113 and 150 cm^{-1} of existing theory. The result are at variance with the published data for $\chi_\perp$ above 85°K, but are in fairly good agreement with the recent findings of Leask and Wo at low temperatures.

9016 PARAMAGNETIC SUSCEPTIBILITY OF $CoCl_2 \cdot 6H_2O$ AND ITS DEUTERATED SALTS. T.Haseda.
J. Phys. Soc. Japan, Vol. 15, No. 3, 483-8 (March, 1960).

The paramagnetic susceptibility of a single crystal of $CoCl_2 \cdot 6H_2O$ was measured by the usual a.c. bridge method. Transition to the antiferromagnetic state was observed at about 3.3°K. The easy axis is along the crystalline c axis. The g values determined in the paramagnetic region, below 20°K are: $g_c = g_b = 4.9$ and $g_c = 2.9$. Some considerations about the anisotropic susceptibilities in the paramagnetic state are given from the standpoint of crystalline field theory. The exchange interaction in this salt is discussed considering the interaction path between the magnetic ions which involves the linkages of chlorine atoms or water molecules. The measurements on the deuterated salts are intended to make clear the effect of the hydrogen bond on the magnetic exchange interaction.

9017 A PRELIMINARY NOTE ON THE MAGNETIC ANISOTROPY AND SUSCEPTIBILITY OF $Fe(NH_4SO_4)_2.6H_2O$. A.S.Chakravarty and R.Chatterjee.
Indian J. Phys., Vol. 34, No. 1, 10-12 (Jan., 1960).

The theory of magnetic anisotropy and susceptibility of Fe^{2+} in Tutton salts has been worked out on the basis of the method of Abragam and Pryce (Abstr. 2821 of 1951). It is found that the anisotropic part of the crystal field changes with temperature du to the thermal expansion of the crystal lattice. The spin-orbit coupling coefficient has to be decreased by 20% from its free ion value of −103 cm^{-1} which indicates some amount of overlap betw the 3d–Fe^{2+} and s- and p-O^{2-} charge clouds. The agreement of theoretical values with experimental is excellent.

9018 MAGNETIC COUPLING IN Pd–DILUTE IRON GROUP ALLOYS. E.O.Wollan.
s. Rev. (USA), Vol. 122, No. 6, 1710-13 (June 15, 1961).
The magnetic properties of palladium and its alloys with iron ıp elements are discussed in terms of the splitting of the d tals. The paramagnetic properties of pure palladium are ounted for on the basis that the holes in the d shell are associated the nonoverlapping e orbitals, whereas the ferromagnetic pling in the face-centred 3d elements and their alloys is ociated primarily with holes in the overlapping t orbitals. On basis and on the basis of a change in the splitting when palladium lloyed with 3d metals, it is possible to account for the para- netic and ferromagnetic properties of the Pd–dilute iron group ys. Because of the larger amount of available data, attention iven primarily to the Pd–Fe system.

MAGNETIC PROPERTIES OF K_2ReCl_6. See Abstr. 8988

9019 ON THE PARAMAGNETIC INELASTIC SCATTERING OF NEUTRONS DUE TO IONS IN THE ANISOTROPIC YSTALLINE FIELD. Y.Yamada.
Phys. Soc. Japan, Vol. 15, No. 3, 429-35 (March, 1960).
The paramagnetic inelastic scattering of neutrons due to ions 3d transition elements in the anisotropic crystalline field was sidered. When the orbital momentum of the paramagnetic ions ıot quenched, the spin states are no longer degenerate but split discrete levels. The transition between these levels can occur magnetic dipole interaction of ions with neutrons, neutrons ing or gaining the corresponding energy. In the special case of Cl_2, an antiferromagnetic crystal whose Néel temperature is K, the calculation of the forward scattering cross-sections of trons in various temperatures and wave lengths were carried which showed that it is possible, in the ordinary conditions, to erve the inelastically scattered neutrons, and whence to obtain ormation about the energy level scheme of the atomic spin in crystal.

9020 ON THE ANOMALY OF THE RIGHI–LEDUC EFFECT IN THE SYSTEM Ni–Cu. F.Dannhaüser and K.M.Koch.
Naturforsch. (Germany), Vol. 16a, No. 2, 215-16 (Feb., 1961).
German.
A new series of experiments with improved apparatus on er samples substantially confirmed previous results (see Abstr. 9 of 1959). The anomalous behaviour of the Righi–Leduc effect ccompanied by a change of sign of the variation of the thermo- ctric powers with magnetic field. These effects are connected the transition from paramagnetism to ferromagnetism.
L.Pincherle

9021 AN ANALOGUE METHOD FOR DEALING WITH MAGNETIC FIELDS IN NONLINEAR ANISOTROPIC DIA. P.A.Tschopp.
.. Assoc. Suisse Elect. (Switzerland), Vol. 52, No. 6, 185-92 rch 25, 1961). In German.
Refers to a method of representing the magnetic field distri- on in a ferromagnetic medium by means of an electrical ogue composed of lumped circuit elements. By suitably sting the element values for each amplitude setting of the ied field, the effect of nonlinear responses, due to hysteresis, be taken into account.
V.G.Welsby

FERROMAGNETISM OF AN ELECTRON GAS.
Abstr. 8900

9022 FERROMAGNETISM IN DILUTE SOLUTIONS OF COBALT IN PALLADIUM.
.Bozorth, P.A.Wolff, D.D.Davis, V.B.Compton and J.H.Wernick.
s. Rev. (USA), Vol. 122, No. 4, 1157-60 (May 15, 1961).
Measurements of the magnetic properties of solid solutions of lt in palladium show that ferromagnetism exists in solutions as e as 0.1 at.% of cobalt, in which the cobalt atoms are about tomic diameters apart. The ferromagnetic Curie point is estab- ed in this alloy by three different methods as 7°K. Bohr magneton bers are determined for the whole series of alloys, and the ent associated with one cobalt atom is found to increase with ion from 1.7 Bohr units in pure cobalt to a limit of 9 to 10 units e greatest dilution. Lattice constants measured at room tem- ature show the effect of the onset of ferromagnetism at about t.% cobalt. A simple model explains the magnitude and variation e cobalt moment.

9023 INTERNAL MAGNETIC FIELDS IN MANGANESE–TIN ALLOYS.
L.Meyer-Schützmeister, R.S.Preston and S.S.Hanna.
Phys. Rev. (USA), Vol. 122, No. 6, 1717-20 (June 15, 1961).
The hyperfine fields at the tin sites in two Mn–Sn alloys were studied, using Sn^{119} γ-ray resonant absorption, as a function of temperature to above the Curie points. In addition to the Zeeman splittings, observed and analysed previously (Abstr. 621 of 1961), a possible quadrupole interaction of about 27 Mc/s is observed in Mn_2Sn. In Mn_4Sn the hyperfine field is small and negative, about −45 kOe; in Mn_2Sn it is large and positive, about +200 kOe. As in the case of the pure ferromagnetic transition elements, it seems necessary to invoke a positive term associated with conduction-electron polarization and a negative one arising from core polarization to explain these results.

9024 MAGNETIC CHARACTERISTICS OF SOME INTERMETALLIC COMPOUNDS BETWEEN MANGANESE AND THE LANTHANIDE METALS. L.V.Cherry and W E.Wallace.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 3, 340S-341S (March, 1961).
The lanthanide metals have been observed to form a large number of intermetallic compounds with the transition metals of the first long period. The compounds have compositions corresponding to the formulas AB_2 and AB_5, in which A represent the lanthanide and B is Fe, Co, Ni or Mn. In previous studies (see Abstr. 9041 of 1961) the ACo_5 compounds were found to exhibit unusual magnetic behaviour. The present study, which deals with the seven isomorphous AMn_5 compounds in which A is Sm, Gd, Tb, Dy, Ho, Er, and Y, was undertaken to ascertain whether this is also the case when the B component is Mn. The magnetization-temperature behaviour of these compounds was investigated between 80 and 550°K. Curie points were observed in all cases, the Curie temperature diminishing steadily with increasing atomic number from 465°K for $GdMn_5$ to 415°K for $ErMn_5$. The Curie temperature for YMn_5 was found to be 490°K. For all the compounds, except YMn_5 the magnetization increases rapidly with decreasing temperature near 80°K, suggesting the existence of a second Curie point. This may be caused by the onset of the alignment of the lanthanide moments or, since there are at least two crystallographically distinguishable Mn's present, to ordering of the moments of a second type of Mn. Saturation magnetizations are presented for 80° and 298°K. The values (in Bohr magnetons per AMn_5 unit) at 80°K range from 1.72 for $SmMn_5$ to 6.23 for $GdMn_5$. The corresponding value for YMn_5 is 2.21. These data seem to indicate that the lanthanide moments are aligned in some way at low temperatures, but knowledge of the details of the manner of coupling must await further work.

9025 DISTRIBUTION OF THE MAGNETIZATION IN A FERROMAGNET. M.W.Muller.
Phys. Rev. (USA), Vol. 122, No. 5, 1485-9 (June 1, 1961).
The distribution of the magnetization is calculated for a thick ferromagnetic slab with easy axis transverse to the plane of the slab in a large applied field in the plane of the slab. The calculation predicts a stable nonuniform distribution which has several features suggestive of the domain pattern to be expected in such a system. In particular, the pattern consists of alternating strips having approximately the periodicity expected from conventional domain theory; and incipient flux closure domains appear if the anisotropy field is smaller than the demagnetizing field.

9026 THE DYNAMIC BEHAVIOUR OF BLOCH WALLS IN GRAIN-ORIENTED SHEETS. P.K.Hermann.
Z. angew. Phys. (Germany), Vol. 13, No. 3, 136-9 (March, 1961). In German.

9027 CALCULATION AND MEASUREMENT OF THE INTERNAL DEMAGNETIZATION COEFFICIENT.
G.Vogler.
Ann. Phys. (Germany), Vol. 7, No. 5-6, 268-79 (1961). In German.
Elaborates previous work (Abstr. 9275 of 1957). The coefficient is calculated to be $N_i = N_T - Gv$, where N_T is the demagnetization coefficient of one of the particles constituting the ferromagnetic body, v is the packing factor and G a structure factor which is calculated for a number of arrays. The relation is tested for carbonyl iron dispersed in rubber and found to be obeyed in high enough fields.
E.P.Wohlfarth

9028 Ni–Fe SINGLE-CRYSTAL FILMS AND THEIR MAGNETIC CHARACTERISTICS.

R.R.Verderber and B.M.Kostyk.

J. appl. Phys. (USA), Vol. 32, No. 4, 696-9 (April, 1961).

Single-crystal, 80–20 Ni–Fe thin films were grown by the vacuum deposition of Ni–Fe alloy onto the (111) and (100) crystal face of CaF_2 single-crystal substrates. The orientation of the thin films was determined by the Geiger counter X-ray reflection technique. The crystal orientation developed in the films is dependent upon the substrate temperature and the crystal face of the substrate upon which the Ni–Fe is deposited. The coercive force, rotational saturation field, and selectivity of the thin films are measured on a 60-cycle hysteresis loop tracer and compared to the magnetic properties of the films deposited upon amorphous substrates.

9029 VOLUME MAGNETOSTRICTION OF COBALT–NICKEL ALLOYS. T.Kaneko.

J. Phys. Soc. Japan, Vol. 15, No. 3, 463-5 (March, 1960).

Forced volume magnetostriction of cobalt–nickel alloys with 10, 20 and 30 at.% Ni content was measured by means of resistance strain-gauge up to the magnetic field of 15000 Oe. It was observed that the fractional volume change per oersted of these alloys after technical saturation were smaller than 1×10^{-10} Oe^{-1}. The result is consistent, at least qualitatively, with Patrick's experimental results of the change of the Curie temperature with hydrostatic pressure.

9030 ORIGIN OF MAGNETOELASTIC EFFECTS IN COBALT–IRON FERRITE. J.C.Slonczewski.

J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 335-53 (Oct., 1960).

The dependence of magnetostrictive strain and elastic coefficients on temperature and orientation of spontaneous magnetization is calculated for the special case of a cubic crystal containing an orbitally degenerate transition ion in a trigonal crystal field. The functional dependence of strain on orientation has a special form which cannot be expressed by means of standard phenomenological formulae. The strain is an order of magnitude larger than that which Tsuya (1957) calculated for certain ferrites not involving orbital degeneracy. The temperature dependence of strain agrees partially with measurements in cobalt–iron ferrite. By fitting theory to experiment a trigonal-field splitting of about 1600 cm^{-1} for the ground state of the cobalt ion is inferred. An orbitally degenerate transition ion should have a large electrical polarizability because its first excited state is separated from the ground state by only spin–orbit energy. This polarizability is shown to give rise to elastic energy which depends on orientation of magnetization. This energy should be appreciable in cobalt–iron ferrite.

9031 THEORY OF MAGNETOSTRICTION IN COBALT-MANGANESE FERRITE. J.C.Slonczewski.

Phys. Rev. (USA), Vol. 122, No. 5, 1367-72 (June 1, 1961).

The magnetostrictive effect of an orbitally degenerate magnetic ion in a cubic ferromagnet is calculated in detail using crystal-field theory. In contrast to previous work (see preceding abstract), it is not assumed that interatomic exchange energy is large compared with spin–orbit energy. The results are applied to the effect of cobalt in cobalt-manganese ferrite. It is found that the theory is consistent with experimental results for the magnetostrictive parameters λ_{100} and λ_{111} in the compound $Co_{0.245}Mn_{0.747}Fe_{1.99}O_4$ from 225°-355°K. By fitting theory to experiment, a trigonal splitting of about 630 cm^{-1} for the ground state of the cobalt ion is inferred. The trigonal splitting has less than half its value in cobalt-iron ferrite.

9032 EFFECT OF ELASTIC STRESSES AND THERMO-MECHANICAL TREATMENT ON THE MAGNETIC PROPERTIES OF SOME HARD MAGNETIC MATERIALS.

M.G.Luzhinskaya and Ya.S.Shur.

Fiz. Metallov i Metallovedenie (USSR), Vol. 4, No. 2, 239-44 (1957).

The following alloys were studied: 8% V, 52% Co, 40% Fe; 14% V, 52% Co, 34% Fe; 15% Mn, 85% Fe. The specimens were stressed by extension and torsion; the thermo-mechanical treatment consisted of applying unilateral tension loading during annealing (to produce high coercivity). The magnetic properties of all three alloys were found to be modified, due to changes in their magnetic texture and anisotropy.

9033 MAGNETIC VISCOSITY DUE TO SOLUTE ATOM PAIRS. II. EXPERIMENTAL RESULTS.

G.Biorci, A.Ferro and G.Montalenti.

J. appl. Phys. (USA), Vol. 32, No. 4, 630-5 (April, 1961).

For Pt I, see Abstr. 1226 of 1961. The theory of magnetic viscosity due to solute atom pairs has been verified on several b.c.c. alloys. The results on Fe–Si alloys with Si content up to 6% wt. show that solute atom pairs give magnetic viscosity. If the strong effect of the temperature is taken into account, the induced anisotropy energy deduced from the viscosity field can be considered in agreement with the value measured directly from th magnetization curves. The result on a series of Fe–Al alloys up 25 at.% Al, where order occurs, further confirm the theory. The viscosity field is, with reasonable agreement, proportional to the number of solute atom pairs, as deduced from studies on ordering of the alloy and from the internal friction resulting from corresponding stress-induced ordering.

9034 CHANGE OF THERMAL AND ELECTRICAL CONDUCTIVITY OF FERROMAGNETICS IN A MAGNETIC FIELD. H.Papadimitraki.

Z. Naturforsch. (Germany), Vol. 16a, No. 2, 217 (Feb., 1961). In German.

Relative thermal and electrical conductivity measurements in applied magnetic fields were made for nickel and the results a presented as graphs of relative change of thermal resistance as a function of temperature T, with $0 < T < 400°C$, and Lorentz number as a function of longitudinal field H, with $0 < H < 4000$ Oe The thermal conductivity is increased by a transverse, and decreased by a longitudinal field. A monotonic relationship exist in the first case but a magnetoconductivity minimum of 7% was found in a longitudinal field of about 1000 Oe. A change in therm conductivity with field could just be detected, but the effect was t small to allow quantitative deductions. No details are given of th experimental techniques employed, nor of the specimen size, whi would allow an estimate of demagnetizing fields. R.Park

NUCLEAR MAGNETIC SPECIFIC HEAT IN FERROMAGNETI IRON ALLOYS. See Abstr. 8882

9035 THE THERMOMAGNETIC BEHAVIOUR OF COBALT FERRITE. L.F.Bates and A.J.Pacey.

Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 567-75 (March, 1961).

The small heat changes accompanying the magnetization of cobalt ferrite were measured with two rod specimens. One had been heat-treated to destroy uniaxial anisotropy, the other was untreated A new method of analysis of the results is described, and while its appli cation to these specimens may not have led to conclusive results it appears to give useful information when applied to materials of less complex magnetic behaviour.

9036 HYPERFINE STRUCTURE OF Fe^{57} IN YTTRIUM-IRO GARNET FROM THE MÖSSBAUER EFFECT.

C.Alff and G.K.Wertheim.

Phys. Rev. (USA), Vol. 122, No. 5, 1414-17 (June 1, 1961).

The hyperfine structure of Fe^{57} in $Y_3Fe_2(FeO_4)_3$ was obtained through the Mössbauer effect. A 0.002 in. thick slice of a single crystal of yttrium iron garnet, cut normal to a [110] direction, wa used as an absorber of recoil-free gamma rays emitted by a stain less steel source. The iron in yttrium iron garnet is located in t nonequivalent sites, tetrahedral and octahedral, each of which has an axially symmetric electric field gradient. Data were taken wit the magnetisation aligned in a [111] and in a [100] direction in orc to produce the simplest absorption pattern. For each direction of magnetisation, the absorption lines of Fe^{57} at both sites were resolved. The magnetic field at an Fe^{57} nucleus was found to be 3.9×10^5 Oe at a tetrahedral site and 4.7×10^5 Oe at an octahedra site when the crystal is at room temperature (~300°K). The quadrupole coupling was found to be 7.5×10^{-8} eV in the tetrahed site and 9.0×10^{-8} eV in the octahedral site.

9037 STUDY OF THE LOW-TEMPERATURE TRANSITION IN MAGNETITE AND THE INTERNAL FIELDS ACTI ON IRON NUCLEI IN SOME SPINEL FERRITES, USING MÖSSBAUER ABSORPTION. R.Bauminger, S.G.Cohen, A.Marin S.Ofer and E.Segal.

Phys. Rev. (USA), Vol. 122, No. 5, 1447-50 (June 1, 1961).

A study was made of the internal fields acting on Fe^{57} nuclei in some spinel ferrites, with particular reference to the low-temperature order–disorder transition in magnetite, using the techniques of Mössbauer absorption. For the Fe^{3+} ions at both th octahedral and tetrahedral sites in nickel ferrite ($NiFe_2O_4$) at 300°K, γFe_2O_3 at 85° and 300°K, and magnetite (Fe_3O_4) at 85°K, t effective magnetic field at the Fe^{57} nuclei is the same and equal t about 5.1×10^5 Oe. In magnetite, the value of H_{eff} in the Fe^{2+} io is about 4.5×10^5 Oe at 85°K. Measurements on Fe_3O_4 at room temperatures provide a microscopic confirmation of Verwey's

othesis (Abstr. 2331-2 of 1947) that above the transition temper-
re of magnetite there is a fast exchange between the ferrous and
ic ions in the octahedral sites.

9038 THE IRREVERSIBLE CHANGE OF MAGNETIZATION PRODUCED IN "SQUARE LOOP" FERRITE BY PULSED GNETIC FIELDS. J.E.Knowles.
c. Phys. Soc. (GB), Vol. 77, Pt 3, 576-86 (March, 1961).
A core of square loop ferrite was examined under pulse magnet-
ion conditions. Starting from remanence, the irreversible
nge of magnetization produced by a series of very short pulses
measured by a ballistic galvanometer method. The results were
rpreted on the basis of a domain wall model, which enabled an
mate to be made of the ratio of the time spent by the walls in
ersible motion to the time spent in irreversible motion. From
ratio was deduced the average number of times that the domain
l energy passed through a maximum during the course of a
gnetization reversal. The result so obtained, twenty-five, agreed
l with that obtained by an independent method, due to Néel.

9039 DIRECTION OF INTERNAL FIELDS IN RARE EARTH IONS.
E.Caspari, S.Frankel, D.Ray and G.T.Wood.
ys. Rev. Letters (USA), Vol. 6, No. 7, 345-6 (April 1, 1961).
The signs of magnetic fields acting at the nuclei of rare
th ions in rare-earth iron garnets were measured by observing
rotation of the angular correlation pattern obtained in
$\rightarrow 2^+ \rightarrow 0^+$ transitions in the rare earth nuclei. For Sm and Dy
contributions to the internal magnetic field arising from s
ctrons exchange-coupled to the f shell electrons are not
ficiently large to change the sign or the observed internal field.
Eu and Gd, however, the main source of field, which is much
aller than in Sm and Dy, may be the exchange-coupled contribu-
n. J.M.Baker

9040 DOMAIN WALL BEHAVIOUR IN RECTANGULAR LOOP FERRITES. J.E.Knowles.
angew. Phys. (Germany), Vol. 13, No. 4, 185 (April, 1961).
"Ferromagnetism Working Party", Wiesbaden, 1960 (see Abstr.
6 of 1961). A short contribution, substantially as follows: Using
Bitter technique, the progress was followed of a magnetization
ersal in a grain of polycrystalline manganese magnesium ferrite.
e grain was roughly cubic in shape and possessed two 180° walls,
motion of which was impeded by obstacles of uncertain origin.
e hysteresis loop of the grain resembled that of the polycrystalline
mple. This similarity prompted a theoretical investigation of the
rage loop shape to be expected from a cubic grain carrying a 180°
main wall lying parallel to the applied field, the motion of the wall
ng impeded by obstacles of random magnitude and distribution.
olution was obtained on the basis of a model due to Néel (1942),
it appeared that such a grain would generally show an approxi-
tely rectangular loop. A model for the domain configuration in
are loop ferrites was then proposed based on the work of Wijn
l. [Abstr. 2400B of 1955; Philips tech. Rev., Vol. 16, No. 2,
58 (Aug., 1954)], but with the additional assumption that all
ins had perfectly rectangular loops, the coercive forces of which
e distributed randomly about some mean value. Theoretical
teresis loops were plotted for varying spreads in the grain co-
ive force, and for either a predominant magnetocrystalline or
gnetostrictive anisotropy. Domain wall velocities were estimated
bserving how far a domain wall on a grain was moved by a
gnetizing pulse of a given duration and amplitude. The most con-
tent set of results, upon a manganese magnesium ferrite compo-
on, gave the velocity as equal to 985 (H − 0.62) cm/sec, where
as the applied field in Oe. See Abstr. 13823 of 1960; 6360 of
1.

9041 INTERMETALLIC COMPOUNDS BETWEEN LANTHANONS AND TRANSITION METALS OF THE ST LONG PERIOD. II. FERRIMAGNETISM OF AB_5 COBALT MPOUNDS. K.Nassau, L.V.Cherry and W.E.Wallace.
Phys. Chem. Solids (GB), Vol. 16, No. 1-2, 131-7 (Nov., 1960).
For Pt I see Abstr. 7877 of 1961. Magnetizations were deter-
ed at various temperatures for a series of substances repre-
ted by the type formula ACo_5, in which A is either Ce, Sm, Gd,
Ho, Y or a mixture of Gd and Y. The purpose of the study was
scertain whether the atomic moments are aligned, at sufficiently
temperatures, and if so to elucidate as far as possible the
ire of the alignment. The magnetization—temperature curves
YCo_5 and $SmCo_5$ indicate them to be normal ferromagnetic
compounds at least down to 80°K, with Curie points at 975 and 1015°K, respectively. Their saturation magnetic moments indicate that the cobalt moments are aligned ferromagnetically. The curves for the other compounds show well defined Curie temperatures ranging from 685 to 1125°K but are unusual in that below a certain temperature, ranging up to 575°K, magnetization shows an anomalous fall with diminishing temperature. Analysis of these results and the observed saturation magnetizations show that the moments are aligned, but not ferromagnetically. The compounds appear to be ferrimagnetic. A discussion of the possible modes of alignment is presented. Thermomagnetic analysis shows that in most instances the compounds decompose when heated to the point at which the alignment of the atomic moments is destroyed.

9042 MAGNETIC STRUCTURE OF CHROMIUM SELENIDE. L.M.Corliss, N.Elliott, J.M.Hasting and R.L.Sass.
Phys. Rev. (USA), Vol. 122, No. 5, 1402-6 (June 1, 1961).
The magnetic structure of the NiAs-type compound, CrSe, was determined by means of neutron diffraction. The indexing of superstructure lines which appear below the Néel point requires a unit cell three times as large as the conventional unit ($a = \sqrt{3}a_{NiAs}$). Planes parallel to the basal plane contain three chromium atoms whose spins form an "umbrella"-like array with threefold symmetry. Individual moments alternate in sign along lines parallel to the c-axis. A value of 2.90 μ_B is deduced for the component of the chromium moment perpendicular to the c-axis.

9043 STATISTICAL MECHANICS OF ANTIFERROMAGNETIC LAYER CRYSTAL, $FeCl_2$. S.Yomosa.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1068-76 (June, 1960).
For the spin system in $FeCl_2$ a statistical theory was developed with the Bethe—Peierls method and used to perform the numerical calculations to compare the results with experimental data of the antiferro–ferro transition. The results are also compared with those obtained by the molecular field approximation. The short range correlation gives rise to the following effects: the decrease of the Néel temperature, a more rapid increase of the sublattice magnetization with decreasing temperature, and a larger critical magnetic field of the antiferro—ferro transition. From the experimental data of the critical magnetic field of the antiferro—ferro transition, the values of two exchange coupling constants are estimated. For these values, it is concluded from theoretical considerations that the antiferro—ferro transition is of the first kind in almost the whole temperature region below the Néel point.

9044 ON THE MAGNETIC SUSCEPTIBILITY OF FeF_2. A.Honma.
J. Phys. Soc. Japan, Vol. 15, No. 3, 456-63 (March, 1960).
Adopting the effective Hamiltonian by Pryce and the molecular field approximation, the parallel and perpendicular susceptibilities of FeF_2 are calculated. According to the experiments by Stout and Matarrese, the perpendicular susceptibility below the Néel point decreases with decreasing temperature. Denoting the components of the D-tensor in Pryce's effective Hamiltonian by D_i (i = x, y, z) where the z-axis is taken as the c-axis and the x-axis as the direction of the line connecting two nearest neighbouring F ions, this behaviour of the perpendicular susceptibility can be explained if Dx, Dy > Dz. The parallel susceptibility at absolute zero has a non-zero value proportional to $(Dx - Dy)^2$. However this term is of the same or small order compared with the temperature-independent part of the magnetic susceptibility. Comparisons with experiments are made by using the values of the D-tensor and the g-factor obtained by Tinkham. If the reasonable values of exchange integrals are adopted, the calculated susceptibilities are in good agreement with the experimental results by Stout and Matarrese.

9045 MAGNETIC ANISOTROPY MEASUREMENT OF MnO SINGLE CRYSTAL.
E.Uchida, H.Kondoh, Y.Nakazumi and T.Nagamiya.
J. Phys. Soc. Japan, Vol. 15, No. 3, 466-74 (March, 1960).
The magnetic anisotropy of a MnO single crystal, grown by the Verneuil method, was measured using a torque balance. The results of the torque measurements at liquid air temperature could be summarized within experimental errors by a formula

$$T = C_1H^2 \sin(2\theta + \epsilon_1) + C_2H^4 \sin(4\theta + \epsilon_2) + C_3H^6,$$

where H is the applied field intensity, θ the angle of rotation of H relative to the crystal, and ϵ's and C's are constants which depend in a certain way on the kind of crystallographic axis of suspension. In the case where [111] is the direction of suspension, $C_2 = 0$. The C_3H^6 term changed its sign when the rotation was made in the

reverse sense; thus it represents a rotational hysteresis term. Alternative theoretical interpretations of the new 4θ term are presented: it arises either from a possible small anisotropy energy within the easy plane of magnetization, or from reversible movements of the walls which separate different antiferromagnetic domains. Discussion to favour the latter is given.

9046 ANTIFERROMAGNETISM OF MIXED CRYSTALS OF ZINC AND MANGANESE FLUORIDE.
J.M.Baker, J.A.J.Lourens and R.W.H.Stevenson.
Proc. Phys. Soc. (GB), Vol. 77, Pt 5, 1038-41 (May, 1961).

An attempt was made to measure the Néel temperature of mixed crystals of various composition by finding the temperature T_c at which the nuclear magnetic resonance of the fluorine nuclei disappears on cooling from room temperature. The dependence of T_c upon concentration of manganese is compared with theoretical predictions. Measurements of the variation of line-width with temperature above T_c are also discussed.

Magnetic Resonances

9047 FERROMAGNETIC RESONANCE IN NICKEL–COPPER ALLOYS. D.M.S.Bagguley and M.Heath.
Proc. Phys. Soc. (GB), Vol. 77, Pt 4, 913-16 (April, 1961).

Absorption was measured in a series of nickel–copper alloys having compositions Ni 50% Cu 50%, Ni 45% Cu 55%, Ni 42% Cu 58% by weight. The temperature range over which measurements were made included the individual Curie points of the alloys. The experiments were carried out at 3.19 cm and 8.8 mm wavelength. Absorption lines were observed in both the ferromagnetic and paramagnetic phases, and the line-width was found to be a maximum at the Curie point. It was also frequency dependent, being roughly twice as great at 8.8 mm as compared with 3.19 cm. The g factor had the value 2.22 ± 0.02 for the ferromagnetic phase of each alloy.

9048 STUDY OF FERROMAGNETIC RESONANCE IN CONDUCTING MATERIALS (X-BAND) MEASURED IN SILICON–IRON MONOCRYSTALS. A.S.Strub.
J. Phys. Radium (France), Vol. 21, Suppl. No. 3, 43A-51A (March, 1960). In French.

A specially designed apparatus, together with a magnetic torsion balance, was adapted for investigations on samples with an oriented crystal structure. It was used for measuring two silicon–iron crystals (1.8% Si) in the form of thin disks. The first crystal has a surface parallel to the (001) plane, the second one a surface parallel to the (112) plane. After a theoretical account, experimental results are given and discussed (measurements of anisotropy constant K_1, anisotropy torque $dW/d\theta$, resonance field $H_{Z,res}$, and apparent permeability as a function of H_Z and of the orientation θ). Some essential details of the equipment are described.

9049 SUBSIDIARY ABSORPTION ABOVE FERRIMAGNETIC RESONANCE. P.C.Fletcher and N.Silence.
J. appl. Phys. (USA), Vol. 32, No. 4, 706-11 (April, 1961).

The interaction between magnetostatic modes and spin waves was first discussed by Suhl [J. Phys. Chem. Solids, Vol. 1, 209 (1957)] and was shown to be the source of nonlinear effects at high power in ferrimagnetic resonance. This article extends Suhl's results on the threshold for subsidiary absorption to d c. magnetic fields greater than that required for ferrimagnetic resonance. Some numerical results on the threshold for subsidiary absorption are presented for shapes other than spheres and for magnetostatic modes other than the uniform precession on a sphere. Some general conclusions regarding the shape dependence of nonlinear effects are stated. The theory is then compared with experimental results on yttrium iron garnet and MnZn ferrite.

9050 MAGNETIC RESONANCE IN CANTED FERRIMAGNETS. P.A.Miles.
Phys. Rev. (USA), Vol. 122, No. 4, 1143-6 (May 15, 1961).

The classical theory of the uniform (k = 0) modes of a four-sublattice, planar canted ferrimagnet is developed. Two of these modes should lie in the microwave range for reasonable values of applied field, anisotropy, and exchange constants: the normal low-frequency mode familiar in collinear ferrimagnets and the mode excited by longitudinal r.f. fields at a frequency depending on anisotropy and angle of cant. Observation of this latter mode should allow analysis of ferrimagnetic structures and phase changes.

9051 ANTIFERROMAGNETIC RESONANCE IN MANGANOUS CHLORIDE. D.H.Douglass, Jr and M.W.P.Strandberg.
Physica (Netherlands), Vol. 27, No. 1, 1-17 (Jan., 1961).

The molecular fields and linewidths were measured by magne resonance techniques as a function of temperature, frequency, and orientation. Demagnetization effects were observed. The "10/3 effect" was observed for the paramagnetic state. An effect simila to this was observed in the antiferromagnetic state.

9052 CHARGE TRANSFER AND THE SPIN-HAMILTONIAN FOR THE Cr^{3+} ION. R.Lacroix.
C.R. Acad. Sci. (France), Vol. 252, No. 12, 1768-70 (March 20, 1961). In French.

Although the theory of paramagnetic resonance for the ion Cr^{3+} has been well studied, the effect of the partial covalent bond between the ion and its surroundings has not been considered. TH effect of this bonding on the spin-Hamiltonian is considered.
S.A.Ah

9053 PARAMAGNETIC RESONANCE OF Cr^{3+} IN YTTRIUM OXIDE. J.W.Carson, D.P.Devor and R.H.Hoskins.
Phys. Rev. (USA), Vol. 122, No. 4, 1141-3 (May 15, 1961).

The paramagnetic resonance spectrum of Cr^{3+} in single-crys yttrium oxide was observed at microwave frequencies from 9 to 71 kMc/s at temperatures from 4.2° to 300°K. The spectrum is described in terms of the spin Hamiltonian

$$\vec{\mathcal{H}} = g\beta\vec{H}\cdot\vec{S} + D[S_z^2 - S(S+1)/3],$$

where g = 1.97 ± 0.01, $S = \frac{3}{2}$, and 2D = 72.9 ± 0.2 kMc/s at 300°K and 72.7 ± 0.2 kMc/s at 77°K and 4.2°K.

9054 PARAMAGNETIC RESONANCE OF MANGANESE IN ALKALI-CHLORIDES. H.Yoshimura.
J. Phys. Soc. Japan, Vol. 15, No. 3, 435-44 (March, 1960).

The solution energies of manganese in LiCl and KCl crystals were calculated by applying Haven's method to the systems of $MnCl_2$–alkali chloride and by the use of the experimental value of the solution energy of manganese in NaCl, obtaining 0.85 eV for Li and −2.08 eV for KCl. The paramagnetic resonance spectra of manganese in quenched crystals of LiCl and KCl showed the hype fine structure of divalent manganese ion in the crystalline field wi non-cubic symmetry. By assuming the spin Hamiltonian of ortho hombic symmetry for the divalent manganese ion associated with positive ion vacancy, the values of D and E were calculated as D = 109 ± 10 G and E = 25 ± 10 G for LiCl. The coloration of Mn doped crystals was carried out by γ-ray irradiation or by pointed cathode, and the resonance spectra of the coloured crystals were observed.

9055 PARAMAGNETIC RESONANCE SPECTRA OF f^3 IONS IN A CUBIC SITE. G.Vincow and W.Low.
Phys. Rev. (USA), Vol. 122, No. 5, 1390-2 (June 1, 1961).

The paramagnetic resonance spectra of Nd^{3+} and U^{3+} in the c field of CaF_2 were investigated at 3 cm at 20°K. In the case of N transitions within the lowest quartet $\Gamma_8^{(2)}$ and possibly in the next higher quartet $\Gamma_8^{(1)}$ were observed. The angular behaviour conforms with that predicted by Bleaney's formulism (Abstr. 8096 of 1960) of the spin Hamiltonian of a Γ_8 state. In the case of U^{3+} the are considerable deviations of the experimental g-values from the calculated ones. It is suggested that these deviations are caused by the stronger cubic field. The efficiency of the thermal conversion from axial to cubic site is discussed. Additional lines suggest a new axial centre along the [111] direction.

9056 E.P.R. STUDIES OF SPIN CORRELATION IN SOME IC RADICAL SALTS.
D.B.Chesnut, H.Foster and W.D.Phillips.
J. chem. Phys. (USA), Vol. 34, No. 2, 684-5 (Feb., 1961).

The salts have the formal stoichiometric representation $M^+(TCNQ)^-$ or $M'^+(TCNQ)_2^-$ where TCNQ is the spin-paired mole cule, tetracyanoquinodimethan, $(CN)_2C:C_6H_4:C(CN)_2$, and M^+ and M are diamagnetic cations of the substituted ammonium, phosphonium or arsonium type. These salts are paramagnetic, but also exhibit high electrical conductivities. Their e.s.r. spectra are those of entities in triplet rather than doublet states. Integrated spectral intensity increases as temperature is raised, before passing throu a maximum, and obeys the law expected for a thermally accessibl triplet state of higher energy than a singlet ground state. This en separation is evaluated as 0.034 eV for M'^+ = triethylammonium, 0.062 eV for M' = methyl triphenyl phosphonium or methyl triphen arsonium. In single crystals of the last two substances, below

50° C, the spectra are doublets with separation dependent on crys- orientation. With the assumption that this arises from zero-field itting in the triplet state, parameters are evaluated in the spin- niltonian describing the splitting, and are compared with those similar systems. Behaviour of these spectra with increasing perature above −150° C can be explained by exchange interactions ween triplet states of changing concentration. When M^+ = morpho- um the triplet state is thought to be 0.40 eV above the ground te, and lines can be observed without broadening, up to 125° C.

J.Sheridan

9057 ELECTRON PARAMAGNETIC RESONANCE OF SILVER HALIDES CONTAINING BIVALENT ANIONS.

bert.

Naturforsch. (Germany), Vol. 16a, No. 2, 211 (Feb., 1961). German.

A correction of an earlier paper by the same author (Abstr. 949 of 1960). Omission of a factor 2 is rectified, and energy- el differences for ions are found to be twice those previously icated. Modified interpretations, involving interstitial silver s, are suggested. A few measurements on spectra of silver mide containing tellurium, at 2 - 25 μ wavelengths, are ntioned.

J.Sheridan

9058 PARAMAGNETIC RESONANCE OF BIS-CYCLOPENTADIENYL VANADIUM IN FERROCENE.

H.Dearman, W.W.Porterfield and H.M.McConnell.

chem. Phys. (USA), Vol. 34, No. 2, 696-7 (Feb., 1961).

This work is an extension to the solid state of the investigation the paramagnetic resonance of bis-cyclopentadienyl vanadium anadocene) in benzene solution (Abstr. 4818 of 1959). Experi- ents were performed at room temperature and k-band on single ystals of ferrocene that contained a small quantity of vanadocene. s the zero field splitting parameter (50 ± 3 kMc/s) is considerably rger than the frequency of observation, the $\frac{1}{2} \rightleftharpoons -\frac{1}{2}$ transition is ry anisotropic and occurs at fields well below g = 2.

J.M.Baker

9059 HYPERFINE SPLITTINGS IN THE (HOOC)C^{13}H(COOH) RADICAL. T.Cole and C.Heller.

chem. Phys. (USA), Vol. 34, No. 3, 1085-6 (March, 1961).

Malonic acid containing 39% C^{13} in the methylene position was epared. The e.s.r. spectrum at room temperature and X band ows a C^{13} hyperfine structure having principal values A_{xx} = 12.7 ± 0.5 Mc/s, A_{yy} = 22.8 ± 1.5 Mc/s, A_{zz} = 42.2 ± 1 Mc/s. e unpaired spin density on the methylene carbon is estimated be 0.8 ± 0.08 and to be of probably positive sign. The asymmetry the A tensor in the yz plane is not yet understood. J.M.Baker

9060 ADIABATIC DEMAGNETIZATION IN A ROTATING REFERENCE SYSTEM. C.P.Slichter and W.C.Holton.

ys. Rev. (USA), Vol. 122, No. 6, 1701-8 (June 15, 1961).

Redfield (Abstr. 7257 of 1955; 3052 of 1956) proposed that ler some circumstances, a magnetic resonance should be scribed by saying the spin system has achieved a temperature a reference system which rotates at the frequency of the applied ernating field. He based his proposal on experiments in which racteristic times of observation were long compared to the n—lattice relaxation time. A theory of spin—lattice processes s necessary to analyse the results. The authors describe a set experiments to verify his hypothesis, using times short compared he spin—lattice relaxation, which test his hypothesis without d for a theory of spin-lattice relaxation. The experiments are wn to be similar to conventional adiabatic demagnetization, formed, however, in a rotating reference frame. Redfield's as are thereby presented in a particularly simple form. The erence between reversible and irreversible losses in magnetiza- are illustrated, and it is shown, for example, that one can inver magnetization with respect to the static field by passing through resonance using alternating fields much less than the linewidth. studies were made using the Na resonance in NaCl.

9061 EFFECT OF CHARGE TRANSFER ON PARAMAGNETIC RELAXATION. J.Hue.

t. Acad Sci. (France), Vol. 252, No. 8, 1121-3 (Feb. 20, 1961). French.

The effect on the paramagnetic relaxation time, due to the nsfer of electrons between the paramagnetic ion and the water lecules in a crystal containing Ti^{3+} ions, is calculated, and found e about 2%.

F.Bruin

9062 ON THE THEORY OF SPIN—LATTICE RELAXATION IN PARAMAGNETIC SALTS. R.Orbach.

Proc. Phys. Soc. (GB), Vol. 77, Pt 4, 821-6 (April, 1961).

A spin-Hamiltonian approach to the theory of spin--lattice relaxation in paramagnetic salts is developed in which the orbit—lattice interaction is treated as a perturbation connecting states of the overall spin-Hamiltonian. The approach is much simpler than previous treatments where the spin—orbit and Zeeman effects were treated as perturbations, and is applicable to a wide range of salts including both the iron group and the rare earth group. It is found that, for Kramers salts (ions with an odd number of electrons), many previous results apply quite generally, regardless of the relative size of the spin--orbit and crystalline field terms, but there are important exceptions. For the case of large crystalline field splittings, the relaxation rate (inverse of the relaxation time T_1) varies as H^4T and T^9 for direct and Raman processes respectively, as Van Vleck has previously shown. The so-called Van Vleck cancellation leading to these dependences is derived in a very simple and quite general manner. For small crystal field splittings Δ, less than, or of the order of, the lattice Debye temperature, the relaxation rate varies as H^4T and a $\exp(-\Delta/kT) + bT^9$ for direct and Raman processes respectively. The two coefficients a and b are such that the T^9 term is important only at low temperatures where the exponential term is quite small. These results are in marked contrast with earlier theories.

9063 SPIN--LATTICE RELAXATION TIME OF F^{19} NUCLEI IN Ag_2F. Q.Won Choi and W.G.Clark.

J. chem. Phys. (USA), Vol. 34, No. 5, 1584 (May, 1961).

The spin—lattice relaxation time of F^{19} nuclei in Ag_2F crystals was measured at several temperatures. From the inverse proportionality constant of the relaxation time with respect to temperature in conjunction with the Korringa's theory (Abstr. 1229 of 1951), it is concluded that the relatively large paramagnetic shift observed is not due to the second-order paramagnetism but to the hyperfine interaction between conduction electrons and F^{19} nuclei.

9064 ON THE POWER TRANSFER BETWEEN PARAMAGNETIC SPINS AND CRYSTAL LATTICE. I.

B.Bölger.

Physica (Netherlands), Vol. 26, Vol. 10, 761-74 (Oct., 1960).

The determination of the power transfer parameter η is discussed. The relation between the transient and the steady state method is shown to depend on the degree of internal spin equilibrium. The temperature and field dependences of η for concentrated salts as determined previously by the relaxation method are still unexplained. The influence of spin—spin interactions is considered, but can explain said dependences only when strong spin—spin interactions are present. The failure of the hot phonon theory for concentrated salts is explained on the base of the broadness of the spin spectrum over which energy exchange with the lattice vibrations can take place. The formulae used in the relaxation and the saturation method are for linear systems shown to become identical by a suitable transformation.

9065 ON THE POWER TRANSFER BETWEEN PARAMAGNETIC SPINS AND CRYSTAL LATTICE. II.

B.Bölger, J.M.Noothoven van Goor and K.J.van Damme.

Physica (Netherlands), Vol. 27, No. 1, 18-32 (Jan., 1961).

Measurements are reported on the power transfer in CrK-alum, at liquid helium and hydrogen temperatures, by steady-state saturation of the microwave absorption at 9400 Mc/s. These experiments were carried out at different magnetic concentrations and different directions of the static field A comparison is made with the results obtained by the (non-resonant) relaxation method. It is found that the curves $1/\chi''$ versus high frequency power are concave and not straight lines as expected. At low powers the power transfer parameter η behaves as theoretically expected, at high powers the steady-state and relaxation method yield the same value of η.

9066 ON THE POWER TRANSFER BETWEEN PARAMAGNETIC SPINS AND THE CRYSTAL LATTICE. III.

B.Bölger, J.M.Noothoven van Goor and C.J.Gorter.

Physica (Netherlands), Vol. 27, No. 3, 277-95 (March, 1961).

Measurements are reported on the spin--lattice power transfer parameter η by way of saturation of paramagnetic resonance in CuK- and $CuNH_4$ tutton salt, $CuSO_4 \cdot 5H_2O$, $CuK_2Cl_4 \cdot 2H_2O$, $Cu(NH_4)_2Cl_4 \cdot 2H_2O$, $MnNH_4$- and $CoNH_4$tutton salt. In CuK tutton salt the ansiotropy of η has also been measured. The value of η is found to be varying with the applied power as reported also in a previous article. The values of η at low powers seem to agree with the

theoretical expectations, while the values at high powers correspond with the results of the paramagnetic relaxation measurements. Only for $CoNH_4$ tutton salt the situation is reversed. It is argued that a possible explanation might be found in an inhomogeneous spatial distribution of η in the crystal, presumably because of fast relaxing impurities (exchange pockets). The transformation between the graphs found by the saturation method to those found by the relaxation method is carried out for some cases. It is then concluded that, accepting the impurity relaxation picture, one has also to admit a spin diffusion mechanism differing for the saturation and the relaxation measurements.

NUCLEAR RELAXATION PROCESSES OF A NONEQUIVALENT TWO-SPIN SYSTEM. See Abstr. 8855

9067 MECHANISMS OF DOUBLE RESONANCE IN SOLIDS. J.Lambe, N.Laurance, E.C.McIrvine and R.W.Terhune.
Phys. Rev. (USA), Vol. 122, No. 4, 1161-70 (May 15, 1961).

A study of electron–nuclear double resonance (ENDOR) in ruby and other solids demonstrates the existence of the "distant-ENDOR" effect, which involves a change in the electron paramagnetic resonance (EPR) signal caused by the depolarization of "distant" nuclei (nuclei having negligible hyperfine interaction with the paramagnetic centres). In order to obtain interpretable data on the mechanism, it proved necessary to perform most of the experiments without modulation, observing not the derivatives but the functions x' and x'' themselves, the dispersive and absorptive parts of the spin susceptibility. The former shows a large decrease upon application of r.f. power at a nuclear transition frequency; the latter shows a moderate increase. Both the distant ENDOR (Al^{27} nuclear Zeeman frequencies) and local ENDOR (Cr^{53} hyperfine frequencies) affect the EPR with a response time comparable to the spin–lattice relaxation time of the distant aluminium nuclei. Nuclear–nuclear double-resonance experiments show that applied r.f. corresponding to Cr^{53} nuclear transitions depolarizes Al^{27} nuclei. Both of these observations are consistent with a mechanism involving dynamic nuclear polarization. A theoretical analysis of this mechanism, based on forbidden transitions involving distant nuclei, gives good agreement with observed nuclear polarizations and with the observed behaviour of x', but predicts small increases in z''. The increased absorption signal may be explained by enhanced spectral spin diffusion or by a spin packet considerably wider than assumed. Distant ENDOR is expected to occur quite generally.

9068 TRANSIENT EFFECTS IN NUCLEAR MAGNETIC RESONANCE WITH THE ROTATING CO-ORDINATES METHOD. G.Bonera and P.De Stefano.
Nuovo Cimento (Italy), Vol. 20, No. 2, 316-23 (April 16, 1961).

Some transient effects in nuclear magnetic resonance are studied with the rotating coordinates method which was introduced by Raby, Ramsey and Schwinger (Abstr. 9511 of 1954). A description of the motion of the nuclear magnetization during the transition is given by means of kinematic models.

9069 LARGE ANISOTROPIC KNIGHT SHIFTS IN INTERMETALLIC COMPOUNDS.
R.G.Barnes, W.H.Jones, Jr and T.P.Graham.
Phys. Rev. Letters (USA), Vol. 6, No. 5, 221-3 (March 1, 1961).

Separation of the Knight shift and second-order quadrupole broadening is effected by measuring the linewidth as a function of resonance frequency for different magnetic field strengths. $\nu\Delta\nu = b + a\nu^2$, where $a\nu = \Delta\nu_{\parallel} - \Delta\nu_{\perp} = 3\nu\delta_{ax}$, gives the contribution of the anisotropic Knight shift to the linewidth. Observations were made on Al^{27} in $Ca(Al^{27})_2$, $Yb(Al^{27})_2$ and $Tm(Al^{27})_2$ and also in $Mg(Cu^{63})_2$. The results are interpreted in terms of the spatial distribution of the electron wavefunctions. D.J.Oliver

9070 THEORY OF THE NUCLEAR MAGNETIC RESONANCE OF Co^{59} IN CoO. K.Motizuki.
J. Phys. Soc. Japan, Vol. 15, No. 5, 888-96 (May, 1960).

The nuclear magnetic resonance is calculated, taking into account the interaction between the nuclear spin and the spin moment and residual orbital moment of the cobalt ion, beside the Fermi-type hyperfine interaction. The calculated frequency is 1028 Mc/s. The interaction between the nuclear quadrupole moment, Q, and the electric field gradient at the nucleus splits this resonance line into seven equally spaced lines. For an assumed value of $Q = 0.5 \times 10^{-24}$ cm^{-1}, the line splitting is 6 Mc/s. The dependence of the frequency of the resonance lines on the direction of the applied field is also investigated. It is shown that by observing this dependence the angle of inclination of the spin axis to the tetragonal axis can be deduced. Further, theory of the indirect coupling between nuclear spins through hyperfine interaction and exchange interaction is developed, using the molecular field approximation. The line width arising from this indirect coupling is estimated to be 0.115 Mc/s which is small compared with the line splitting.

9071 ORIGIN OF THE F^{19} HYPERFINE STRUCTURE IN TRANSITION ELEMENT FLUORIDES.
A.J.Freeman and R.E.Watson.
Phys. Rev. Letters (USA), Vol. 6, No. 7, 343-5 (April 1, 1961).

Previous theories of the isotropic part of the hyperfine structure have considered unpairing of only the 2s electrons on the fluorine atom. This paper points out that the unpairing of the 1s electrons gives an appreciable contribution. This is illustrated using $KMnF_3$ as an example. J.M.Bai

9072 THE EFFECTS OF DEUTERON IRRADIATION ON THE NUCLEAR MAGNETIC RESONANCE IN TEFLON.
H.Kusumoto.
J. Phys. Soc. Japan, Vol. 15, No. 5, 867-74 (May, 1960).

F^{19} magnetic resonance was observed on a non-irradiated sample of Teflon and another irradiated by deuterons. Irradiation caused considerable increase of line width and second moment above -75°C, where an abrupt narrowing of line width caused by the onset of the segmental motion of the molecules took place for both samples. This result suggests that there might exist in the irradiated Teflon some molecular structures disturbing the molecular motion, e.g., cross-linkings, double bonds, formation of ring etc. and increase crystallinity by irradiation. A broad line component superimposed on a sharp absorption line observed in the original Teflon around -7°C faded out as a result of the irradiation. The energies and entropies of activation were computed from the line width data. The irradiation gave them the effects similar to those of curing in natural rubber.

9073 ON THE PROTON RESONANCE OF SEVERAL HEXAMMINE COMPLEX SALTS. P.H.Kim.
J. Phys. Soc. Japan, Vol. 15, No. 3, 445-55 (March, 1960).

Below liquid H_2 temperatures down to liquid He temperatures it seems that the protons of NH_3 ligand are rotating or tunnelling about the three-fold axis in a complex ion of type $M(NH_3)_6$. Above liquid H_2 temperatures, molecular reorientation occurs in addition to rotation or tunnelling of the protons of NH_3 about the three-fold axis. The difference of the line width between the diamagnetic and the paramagnetic salts at room temperature is explained by taking account of the short T_1 in the paramagnetic salts. The magnitude of the observed shift at low temperatures is proportional to the susceptibility and such a relation is derived theoretically by evaluating for a three spin system. Comparing each line width and the shift of the Co and Mn salts with those of Ni salt, it is suggested that the distance between the hydrogen atom and the metal ion in the Co and Mn salts is much larger than that in the Ni salt. In the measurements on the salts $Ni(NH_3)_6Cl_2$ and $Ni(NH_3)_6(ClO_4)_2$ at low temperatures, an unexpected phenomenon occured, the proton line disappearing suddenly, for a reason which is not yet certain.

9074 PROTON MAGNETIC RESONANCE IN HYDROGEN BONDED DIMERS IN SOLIDS.
K.Kume and Y.Kakiuchi.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1277-84 (July, 1960).

It is concluded through proton magnetic resonance examination that the positions of protons in boric acid crystals lie considerably away from the lines connecting two hydrogen bonded oxygens, in contrast to the case in potassium bicarbonate crystals, where the protons are approximately on the oxygen–oxygen lines. The result is discussed in connection with the difference in strength of the hydrogen bond in both cases.

9075 QUADRUPOLE EFFECTS IN THE NUCLEAR MAGNETIC RESONANCE OF DILUTE ALLOYS.
A.Blandin and J.Friedel.
J. Phys. Radium (France), Vol. 21, No. 10, 689-95 (Oct., 1960). In French.

The strong intensity changes in the nuclear magnetic resonance of dilute alloys are the consequence of the electronic density oscillations $\Delta\rho$ which are created at large distances by the dissolved impurities. For a nucleus at a distance r from an impurity, $\Delta\rho$ is proportional to the function $\cos(2k_F r + \varphi)/r^3$ and gives field gradients of the same asymptotic form, multiplied by a constant depending strongly on the s, p or d character of the Bloch wave-

nctions at the Fermi level of the pure metal. The experimental sults for Cu or Al base alloys are discussed. Analogous conclu-ons have been simultaneously obtained by Kohn and Vosko (Abstr. 691 of 1960).

9076 ZEEMAN EFFECT OF NUCLEAR QUADRUPOLE RESONANCE SPECTRUM IN 1,3,5-TRICHLORO-ENZENE. Y.Morino and M.Toyama.
Phys. Soc. Japan, Vol. 15, No. 2, 288-96 (Feb., 1960).

A study of the Cl^{35} resonance spectrum was carried out at the om temperature on a single crystal of 1,3,5-trichlorobenzene. atial orientation of the C–Cl bonds was determined to an accuracy 1°. An orthorhombic structure was inferred, with the unit cell ntaining at least four equivalent molecules oriented with the mmetry of D_{2h}. The angles between the C–Cl bonds in each olecule were close to the hexagonal angle, but one of the C–Cl nds was deformed by $\sim 1.6^{\circ}$ from the plane of the other two. The ymmetry parameters were observed to be 0.09_3, 0.11_1, and 0.12_9 r three absorption lines, 35.020, 35.296, and 35.545 Mc/s spectively. The results are discussed from the viewpoint of ermolecular interaction.

MECHANICAL PROPERTIES OF SOLIDS

9077 A NEW APPARATUS FOR THE EXAMINATION OF THE CREEP OF METALS WITH SPECIAL REFERENCE TO ONTANEOUS EXTENSION. G.Herrendörfer and F.X.Eder.
per. Tech. der Phys. (Germany), Vol. 8, No. 3, 126-32 (1960). German.

An apparatus is described for measurements between 20° and 3°K, using pneumatic loading and photographic recording.
H.Mykura

9078 USE OF THIN BISMUTH LAYERS AS STRAIN GAUGES. G.N.Guk.
z. tverdogo Tela (USSR), Sbornik [Supplement] II, 99-103 (1959). Russian.

Describes experimental work which showed that thin bismuth ers can be used to measure mechanical deformation of surfaces. e strain coefficient (defined as the coefficient of proportionality tween the change in resistance and the deformation) was deter-ned. The current–voltage characteristics were obtained and the pendence of the bismuth layer stability on the type of substrate s investigated.
A.Tybulewicz

9079 A NOTE ON NON-EQUILIBRIUM ELASTIC CONSTANTS. M.A.Jaswon and B.J.Shaw.
oc. Phys. Soc. (GB), Vol. 77, Pt 4, 685-8 (April, 1961).

A new tensor invariant is introduced into elasticity, viz. the rk done by a system of fixed initial stresses in generating second-der dilatations. The effect of the latter can therefore be stematically accounted for, in a crystal of any symmetry class, en making lattice theory calculations of non-equilibrium elastic nstants. Two examples of such calculations are included.

9080 DYNAMIC MECHANICAL PROPERTIES OF IRRADIATED HIGH DENSITY POLYETHYLENES.
Fukada, R.W.B.Stephens and A.Charlesby.
Phys. Chem. Solids (GB), Vol. 16, No. 1-2, 53-9 (Nov., 1960).

The dynamic Young's modulus and the mechanical damping of low density polyethylene (Alkathene) and the high density yethylene (Marlex 50 and Hostalen) subjected to electron adiation were measured at a frequency of 0.2 c/s over a tempera-e range of 20 to 180°C. A remarkable change in the mechanical operties of irradiated high density polyethylene was observed er heat treatment. After an initial heating of an irradiated ecimen above its melting point the elastic modulus at lower mperature decreases and the curve of mechanical damping versus mperature changes. Two peaks appearing in the damping versus mperature curve may be associated with the melting process of groups of small and large size crystals. The crosslinks roduced by electron irradiation at room temperature prevent the large crystals of polyethylene from regaining their original size after attaining the rubber state due to melting. The heat treatment, therefore, produces a larger number of crystals of small size and fewer large crystals, which appears to conform with the tendency to an increase of height and width of the damping peak at lower temperature and a decrease of height of the damping peak at higher temperature.

9081 TEMPERATURE AND COMPOSITION DEPENDENCE OF THE ELASTIC CONSTANTS OF DILUTE ALLOYS OF MANGANESE IN COPPER. D.L.Waldorf.
J. Phys. Chem. Solids (GB), Vol. 16, No. 1-2, 90-9 (Nov., 1960).

The elastic constants of several dilute alloys of manganese in copper were measured in the temperature range from 4.2°K to 300°K by the pulse ultrasonic method. The three measured moduli show temperature dependences similar to those of pure copper. They all exhibited a linear decrease with increasing manganese concentration. The variation of the Debye temperature which was calculated from the 4.2°K values of the elastic constants was found to be about -0.6°K/at.% Mn. This implies an increase in the lattice specific heat within the "T^3" temperature region of ~0.5% per at.% Mn. The composition dependence of the shear moduli indicates that the charge of the Mn ion in the copper lattice is +3e. Since it has been found from magnetic and specific heat measurements that the spin of the ion is s = 4/2, it is concluded that there are four 3d electrons remaining on the Mn ion with parallel aligned spins.

9082 INTERNAL ENERGY AND ELASTIC CONSTANTS OF SILICON IRRADIATED BY FAST NEUTRONS.
G.Mayer and M.Lecomte.
J. Phys. Radium (France), Vol. 21, No. 4, 242-8 (April, 1960). In French.

Silicon monocrystals were pile irradiated with doses of up to 3.7×10^{19} fast neutrons/cm^2. The internal energy and the elastic properties were measured at various stages of the irradiation. The influence of heat treatment on these properties was then investigated. Using the numerical values thus obtained an attempt is made to determine the nature and number of defects induced in these crystals by fast neutrons.

9083 INVESTIGATION OF INTERNAL FRICTION OF SINTERED SUBSTANCES. II. TERNARY SYSTEM COPPER–NICKEL–IRON.
B.Ya.Pines and Den Ge Sen [Têng Ko Sêng].
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 1, 86-90 (Jan., 1960). In Russian.

For Pt I and IV, see ibid., Vol. 8, No. 4, 599 (1959). The temperature dependence of the internal friction of sintered Cu–Ni–Fe alloys was characterized by 6 peaks, attributed to grain-boundary diffusion. Three of these peaks were associated with the processes taking place at boundaries between similar grains, the other three being due to diffusion between grains of different phases. The activation energy E for the internal friction process was determined. The values of E corresponding to the peaks of internal friction were in good agreement with those determined previously for pure Cu, Ni, and Fe, and for their binary alloys. The values of E determined from the frequency displacement of the peaks were considerably higher than those (E') obtained from the "background" of the temperature dependence of internal friction. With increasing duration of the preliminary annealing, E increased and E' decreased.
M.H.Sloboda

9084 INVESTIGATION OF INTERNAL FRICTION IN SINTERED MATERIALS. V. LOW TEMPERATURE EFFECTS DUE TO PLASTIC DEFORMATION.
B.Ya.Pines and Den Ge Sen [Têng Ko Sêng].
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 58-62 (July, 1960). In Russian.

The temperature dependence of internal friction in plastically deformed and sintered Cu and Ni specimens was determined between $+20^{\circ}$ and -150°C. The curves constructed for Cu had one maximum at about -80°C, whereas the internal friction of Ni passed through two maxima, situated in the -35° to -50°C and -95° to -110°C ranges. With increasing degree of plastic deformation, the internal friction peaks were shifted towards the lower temperature region, and their height increased. Curves for fully annealed specimens has no maxima. The activation energy, determined from the frequency displacement of the internal friction peak in Cu, was 5.6 kcal/mol.
M.H.Sloboda

9085 INVESTIGATION OF INTERNAL FRICTION OF SINTERED SUBSTANCES. III. THE EFFECTS OF PLASTIC DEFORMATION. B.Ya.Pines and Den Ge Sen [Têng Ko Sêng].
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 1, 91-9 (Jan., 1960). In Russian.

The temperature dependence of the internal friction of sintered and plastically deformed Cu, Ni, and Fe specimens was studied. In addition to the normal peak associated with diffusion creep along the grain boundaries, peaks due to plastic deformation and attributed to the presence of dislocations were observed at 450-500° C (Cu), 625-660° C (Ni), and 650° C (Fe). With increasing degree of the preliminary deformation, the height of the secondary peaks increased and they were displaced towards the low temperature range. Internal friction of Ni and Cu specimens, annealed isothermally, decreased exponentially with time. The activation energy for the process of restoration of internal friction of plastically deformed Cu and Ni was ~18.6 and 13.4 kcal/mol, respectively. An anomalous relationship between the height of the "background curve" and the degree of deformation was observed: the initial, sharp increase in "background" at low deformation values was followed by a decrease at higher degrees of deformation. M.H.Sloboda

9086 A THEORY [RELATING] INTERNAL FRICTION IN SUBSTITUTIONAL SOLID SOLUTIONS TO RELAXATION OF THE SHORT-RANGE ORDER. V.T.Shmatov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 14-19 (July, 1960). In Russian.

Based on postulates due to Le Claire and Lomer (Acta Metallurgica (Internat.), Vol. 2, 718, 1954), a theory is developed in which the characteristic peak of internal friction in solid solutions is explained in terms of relaxation of the short-range order. Formulae for the degree of relaxation of elastic moduli and for the relaxation time are derived and compared with the experimental data on internal friction in Ag–Zn and Cu–Zn alloys. M.H.Sloboda

9087 INTERNAL FRICTION OF QUARTZ. Y.Hiki.
J. Phys. Soc. Japan, Vol. 15, No. 4, 586-92 (April, 1960).

The internal friction of transparent natural quartz was measured at room temperature with longitudinal vibration in kilocycle range using a composite piezo-electric oscillator. Specimens were cylinders with axes which took various orientations in the crystallographic YZ-plane. The internal friction of specimens parallel to the Y- or Z-axis was small and almost independent of the strain amplitude of the vibration, while that of specimens with other orientations was rather large and showed marked dependence on the amplitude. The experimental results were analysed with the theory of dislocation damping based on the pinned-down dislocation model. It could be concluded that the internal friction of quartz was mainly due to the vibration of dislocations in the slip plane parallel to the Y- or Z-axis. The dislocation density in a specimen was estimated to be 10^3–10^4 cm^{-2}. It was also found that the dislocation density was reduced by annealing the specimen. The defects pinning down the dislocations were assumed to be aggregates of metallic impurities.

9088 MEASURES OF FINITE STRAIN AND STRESS-STRAIN RELATIONS. W.Segawa.
J. Phys. Soc. Japan, Vol. 15, No. 3, 518-22 (March, 1960).

Ordinarily, stress-strain relation of Lagrange's representation is written in terms of Lagrange's representation of stress σ^{ij} and the Love measure e^{L}_{ij}. From the above relation, Reiner's equation can be derived in terms of Euler's representation of stress $T^{\lambda\mu}$ and the Green measure $e^{G}_{\lambda\mu}$. In this paper, it is shown that σ'^{ij} and e_{ij} defined by

$$\sigma'^{ij} = Dx^{*}_{i\lambda} x^{*}_{j\mu} T^{\lambda\mu}, \qquad e_{ij} = \tfrac{1}{2}(\delta_{ij} - g^{ij})$$

can play the role of σ^{ij} and e^{L}_{ij} and starting from stress-strain relation of σ'^{ij} and e_{ij}, Reiner's equation in terms of $T^{\lambda\mu}$ and the Almansi measure $e^{A}_{\lambda\mu}$ is arrived at. Various formulae relating to the four measures above mentioned and to their first variations are also shown, as well as various relations among different strain invariants.

9089 A TEXTURE CONDITIONED SURFACE EFFECT IN THE DRAWING OF THIN POLYCRYSTALLINE SPECIMENS. K.Kolb and E.Macherauch.
Z. Naturforsch. (Germany), Vol. 16a, No. 2, 218 (Feb., 1961). In German.

A study, from X-ray data, of the dependence of the internal stress in the surface layer of a Ni crystal on the degree of formin... L.Pincher...

9090 SHOCK-WAVE COMPRESSION OF IRON AND BISMUT... D.S.Hughes, L.E.Gourley and M.F.Gourley.
J. appl. Phys. (USA), Vol. 32, No. 4, 624-9 (April, 1961).

A helium gun was used to propel metal projectiles against targets of the same materials. Pressures produced by impact wer... varied by varying projectile velocities. The method produced pressures up to somewhat over 100 kbar, thus overlapping the low... part of the range of pressures which can be produced by detonation... of high explosives. Of particular interest was the range of pressu... intermediate between the highest which can be produced statically ... and the lowest which can be produced by explosives. A condenser ... micrometer was used to detect motion of the free surface of the target. This method permitted examination of the motion in greate... detail than could reasonably be accomplished by other methods which have been used. Elastic and plastic waves were observed in... iron and in bismuth. Assuming the Rankine–Hugoniot shock con... ditions, pressures and compressions were computed. Pressure–... compression data for iron were obtained for intermediate pressur... not previously investigated. Phase transitions in bismuth were observed for pressures up to about 40 kbar.

9091 LATENT ENERGY OF PLASTIC DEFORMATION OF SILVER AT –196° AND 20° C.
V.A.Pervakov, V.I.Khotkevich and A.G.Shepelev.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 117-21 (July, 1960). In Russian.

The relationship between the latent energy of deformation Q, degree of deformation $\Delta d/d$, and work of deformation A, was deter... mined for Ag specimens deformed in compression at 20° and –196°... Q increased with decreasing temperature, being 0.45 cal/g at 20° C... and 0.7 cal/g at –196° C. Q/A also increased with decreasing tem... perature but the relationship between Q/A and A was the same at low and high temperature in that Q/A decreased with increasing A ... which indicated that even at –196° C recovery processes take plac... during deformation of Ag. At both temperatures $Q = k\Delta R$, where ΔR is the increase in the electrical resistance of the specimen. Q and the corresponding ΔR of specimens, deformed at room tem... perature to equal $\Delta d/d$, was approximately the same for both com... pression and tension. M.H.Slobo...

9092 EFFECT OF NEUTRON IRRADIATION ON THE PLASTIC DEFORMATION OF COPPER SINGLE CRYSTALS. I.G.Greenfield and H.G.F.Wilsdorf.
J. appl. Phys. (USA), Vol. 32, No. 5, 827-39 (May, 1961).

Copper single crystals subjected to a neutron dose of 3×10^{18}... n.v.t. (total flux) at pile temperature were examined after deform... ation by the following experimental techniques: (a) observation of the load–extension relationships, (b) investigation of the slip-line structure with the electron microscope, and (c) diffraction electro... microscopy of thinned-down single crystals before and after deformation. The critical resolved yield stress is in the order of 1.6 kg/mm^2. In the early stages of deformation, the load–extensio... curves show serrations which are as large as 1.0% of the critical resolved shear stress. In the linear portion of the stress–strain ... curve, the rate of work hardening is less for irradiated single crystals than for the nonirradiated. The stress–strain curves of irradiated and the nonirradiated specimens are similar in the parabolic region of the curves. The slip-line structure, at low deformations, consists of fine slip lines that are clustered togethe... the distances between the slip lines are, on the average, 100 A and... often less; the distances between the clusters are in the order of 4 μ. This structure is quite different than the alpha-brass structure, which in the past was considered typical for irradiated coppe... Cross slip, which is most abundant in the linear hardening region of the stress-strain curve, is found to be orientation dependent. T... slip-line structures for the irradiated and nonirradiated crystals a... high strains are very similar. Prismatic dislocation loops, appar... ently resulting from the condensation of vacancies, are found to be... the most frequently produced radiation defect. The interaction between loops and glide dislocations results in heavily kinked dislo... cations which are probably responsible for the observed high yield... stress. The glide dislocations were seen to remove the radiation ... damage. Because of this cleaning out of radiation-produced defect... and the ability of the dislocations to multiply from new sources, th... prolonged "easy glide range" can be explained. Further, the prop... osed mechanism provides an explanation of the work hardening in the linear and parabolic parts of the stress–strain curve.

9093 MAXWELL'S FORMULA FOR THREE-DIMENSIONAL AND LARGE DEFORMATION. W.Segawa.
Phys. Soc. Japan, Vol. 15, No. 2, 339-44 (Feb., 1960).

The classical Maxwell's formula in the case of a single relaxa- n time is extended so as to be applicable to three-dimensional l large deformations. It is also shown that for small deforma- ns the derived formula reduces to Alfrey's formula which is valid three-dimensional and small deformations. The application to nple elongation is shown to be satisfactory.

9094 ON WORK-HARDENING OF ROCK SALT. V.D.Evdokimov.
z. Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 131-4 ıly, 1960). In Russian.

The (100) plane of a rock salt single crystal specimen was essed against the cylindrical face of a steel rod rotating at 2 m/sec, and the friction-induced work-hardening of the surface ver both within and outside the contact area was studied. The gree of work-hardening (determined by microhardness measure- ents) due to uni-directional friction varied across the zone of ntact, being min. in the region in which tensile tangential forces edominated, and max. in the compression zone. The gradually minishing increase in hardness of the surface layer outside the ne of contact indicated the presence of an intermediate zone in ich both plastic and elastic deformation took place. The results microhardness measurements were confirmed by determination the concentration of dislocations (revealed by etching in carbon rachloride) which was highest in the compression region of the ntact zone. The degree of work-hardening of specimens, tested der conditions of periodic reversal of the direction of sliding, was ver than that due to uni-directional friction loading, and constant ross the contact zone. M.H.Sloboda

9095 THE MECHANISM OF FRACTURE OF METALS IN CREEP. B.Ya.Pines and A.F.Sirenko.
kl. Akad. Nauk SSSR, Vol. 134, No. 5, 1061-4 (Oct. 11, 1960). Russian.

For abstract, see Abstr. 3992 of 1961. [English translation in: viet Physics—Doklady (USA), Vol. 5, No. 5, 1087-9 (March- ril, (1961)].

9096 THE VARIATION OF THE FRACTURE ENERGY OF BRITTLE PLASTICS WITH TEMPERATURE. L.Svensson.
oc. Phys. Soc. (GB), Vol. 77, Pt 4, 876-84 (April, 1961).

A method for the determination of the fracture energy of brittle stics is described. A crack is propagated down the length of a ctangular specimen under controlled conditions and the variation crack opening with length determined. From these results the cture energy may be calculated. The method was applied to ermine the variation of fracture energy for polymethyl- thacrylate and polystyrene with temperature in the temperature ge 20° to 80°C. The results of tests carried out at room- nperature show good agreement with similar results obtained other investigators.

9097 THE ROLE OF ADHESION IN THE ESTABLISHMENT OF FRICTIONAL FORCES ON PURE SURFACES. I.Epifanov.
kl. Akad. Nauk SSSR, Vol. 133, No. 2, 349-51 (July 11, 1960). Russian.

For abstract, see Abstr. 16245 of 1960. [English translation : Soviet Physics—Doklady (USA), Vol. 5, No. 4, 865-7 (Jan.-Feb., 61)].

9098 THE PROBLEM OF FRICTION AND SHEAR UNDER HIGH CONTACT PRESSURES. F.Vereshchagin, V.A.Shapochkin and E.V.Zubova.
z. Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 135-9 ıly, 1960). In Russian.

The effect of the variation of the normal pressure, p, on friction d friction-induced shear was studied on thin Cu and Sn disks placed tween the flat ends of aligned and axially loaded hard alloy cylinders, tating in opposite directions. Friction between hard alloys VK8 and Kh15 was studied in the same manner. The friction-induced in- nal shear stresses increased monotonically with increasing p roughout the range studied ($\leq 5 \times 10^5$ kg/cm^2). In the case of ction between both similar and dissimilar hard alloy specimens, reasing p up to 10^5 kg/cm^2 brought about a gradual increase in the ction forces and caused irregular variation of the friction coef- ient. The results obtained indicated that for any combination of materials there is a certain critical p at which a transition from external friction to internal shear takes place. For the majority of elements and engineering alloys, this critical value varies between 15×10^3 and 50×10^3 kg/cm^2. M.H.Sloboda

STRUCTURE OF SOLIDS

9099 PHASE TRANSITIONS IN THE AMMONIUM HALIDES. R.Stevenson.
J. chem. Phys. (USA), Vol. 34, No. 5, 1757-62 (May, 1961).

High-pressure experiments, using the piston displacement technique were performed at temperatures down to that of liquid nitrogen on NH_4I, NH_4Br, ND_4Br, and NH_4Cl. For the iodide two new phase transitions under pressure and a new triple point were observed. A new transition and a new triple point were observed in both the bromides; the existence of another transition was confirmed. The role of multipole interactions in causing the transitions is discussed, and on the basis of structural data and the experiments a generalized phase diagram is presented which describes the gross behaviour of the transitions in these substances.

9100 ON THE PHASE TRANSITION OF TUNGSTEN TRIOXIDE BELOW ROOM TEMPERATURE. S.Tanisaki.
J. Phys. Soc. Japan, Vol. 15, No. 4, 566-73 (April, 1960).

Microscopic observation, thermal analysis, measurement of electrical resistivity and X-ray study of WO_3 were carried out in relation to the phase transition from room temperature down to $-70°$C. The crystal of WO_3 is monoclinic ($a = 7.30$ A, $b = 7.53$ A, $c = 7.68$ A, $\beta = 90°54'$) at room temperature, and it transforms to triclinic ($a = 7.30$ A, $b = 7.52$ A, $c = 7.69$ A, $\alpha = 88°50'$, $\beta = 90°55'$, $\gamma = 90°56'$) near 17°C, and transforms to monoclinic ($a = 5.27$ A, $b = 5.16$ A, $c = 7.67$ A, $\beta = 91°43'$) near $-40°$C, on cooling. These two transitions could be clearly observed in the single-domain crystal in the room temperature phase, but phase transitions of complicated appearance were observed in the multidomain crystal owing to a small difference between free energies in the room-temperature phase and the triclinic phase. Both electrical resistivity versus temperature curve and thermal differential curve show a slight anomaly at 17°C transition and a remarkable anomaly at $-40°$C transition.

CRYSTALLOGRAPHY

9101 SELENIUM AND ITS CRYSTALLOGRAPHIC PROPERTIES. L.Moenke-Blankenburg.
Jenaer Jahrbuch (Germany), 1959 I, 211-25. In German.

A summary of the crystalline properties of selenium, which can be obtained in three polymorphic forms. A microscopic examination of the crystallization of selenium under different conditions of temperature etc. shows the formation of concentric layers in spherulites. Many illustrations are included. J.Iball

9102 A POSSIBLE MODE OF TWIN IN THE ϵ-PHASE OF Cu-Sb ALLOY. M.Doi.
J. Phys. Soc. Japan, Vol. 15, No. 5, 849-52 (May, 1960).

Only one symmetry plane (1210) was found in the superlattice, where an ideal distribution of 8 Sb atoms was assumed in the unit cell. This symmetry plane coincides with the plane of shear and is normal to the twinning plane $(10\bar{1}1)$, of the twin which was previously predicted for the hexagonal lattice with the axial ratio 0.7947. Assuming that the $(10\bar{1}1)$ twin is present in the ϵ-phase, atom movements during twinning are discussed. The possibility of detectable twins of this type seems so small that it may be 1/6 (or less) of the possibility for the $(10\bar{1}2)$ twin in common h.c.p. metals. Cahn has confirmed that no twin can form in an ordered Fe_3Al crystal. Based on this, some geometrical conditions for the twinning of superlattices are assumed.

9103 DYNAMIC BEHAVIOUR OF TWINNING IN TIN CRYSTALS AT VARIOUS TEMPERATURES AND STRAIN RATES. S.Maruyama.
J. Phys. Soc. Japan, Vol. 15, No. 7, 1243-51 (July, 1960).

The resolved shear stress for twinning became large and the scatter of individual values was pronounced, as the temperature was lowered and strain rate was increased. The observed twinning stress was not so large as to expand the stacking-fault across the crystal, but it was sufficient to trigger a twin nucleus if local stress concentration was produced, say, by dislocation pile-ups. As the

temperature was raised and strain rate was decreased, deformation by slip preceding twinning became dominant, and twin formation was finally prohibited. The activation energy derived from the ductile—brittle transition temperatures is approximately that of self diffusion, suggesting that recovery due to dislocation climb releases local stress and prohibits twin nucleation. Hardening of twin boundary migration was found at low temperatures or at high strain rates, while the initial migration stress was not raised by these factors but raised by prestrain. It was about one order of magnitude smaller than that for twin initiation, and too small for the creation of twin dislocation ring on the existing twin layer. A mechanism of sweeping and climbing of the twin dislocation around a pole dislocation is necessary to explain the observed value.

9104 ETCH PATTERNS ON CADMIUM CRYSTALS GROWN FROM VAPOUR. J.George.
Nature (GB), Vol. 189, 743-4 (March 4, 1961).

An etching solution of picric acid in acetone acting for 2 min produces spiral patterns with hexagonal symmetry on the basal planes of some crystals. The etch pits are formed at the sites of dislocations. 2 photographs. F.Ansbacher

9105 SPIRAL ETCH-PITS OF ICE CRYSTALS. J.Muguruma.
Nature (GB), Vol. 190, 37-8 (April 1, 1961).

Electron-photomicrographs are reproduced of replicas from etched ice surfaces nearly perpendicular to c-axis; these show clearly the stepped structure of the spiral pattern of minute etch-pits (size ~ 1 μ). The step heights were estimated to be from 200 to 2000 A, which are of the same order of magnitude as the step structure on a growing ice surface reported previously (Abstr. 785 of 1956). F.Ansbacher

9106 ETCHING OF DIAMOND SURFACES WITH GASES. T.Evans and D.H.Sauter.
Phil. Mag. (GB), Vol. 6, 429-40 (March, 1961).

Etching experiments are described in which diamonds showing octahedral, cubic and dodecahedral faces are heated in air within the temperature range of 800° to 1400° C. A change in the etch pit orientations of the characteristic etch pits for these faces has been found as the temperature of etching is raised. Etching with mixtures of gases has led to the conclusion that oxygen and water vapour are the relevant constituents of air in the formation of well-defined etch pits. Surface graphite formation at temperatures below 1400° C is considered and it is proposed that the mechanism of formation is essentially a chemical reaction and not connected with a purely physical phase change.

9107 ACID CUTTING AND ACID POLISHING OF COPPER CRYSTALS. F.W.Young, Jr and T.R.Wilson.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 559-62 (May, 1961).

An acid saw and an acid polisher for cutting and polishing copper crystals are described. Evidence is presented that the cutting and polishing do not introduce dislocations into the crystals. Using these techniques, copper crystals with a dislocation density of 5×10^3 cm^{-2} have been prepared.

9108 ON THE ACTIVATION ENERGY OF GRAIN GROWTH DURING COLLECTIVE RECRYSTALLIZATION OF NICKEL OF VARIOUS DEGREES OF PURITY.
I.I.Novikov and I.L.Rozelberg.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 6, 1132-3 (1958). In Russian.

Experiments were carried out on both high-purity (99.99%) and commercially-pure nickel at temperatures between 600° and 900° C. It was found that the figure for the high-purity nickel is closer to experimental values of the activation energy for self-diffusion of nickel than that for the commercial grade of metal. On the basis of Smoluchowsky's theory of grain growth it is argued that the activation energies for grain growth and self-diffusion should not be identical. [English translation in Phys. Metals and Metallography (GB), Vol. 6, No. 6, 175-7 (1958)]. A.E.Kay

9109 THE INFLUENCE OF SEVERAL FACTORS ON THE GROWTH OF SUB-GRAINS IN POLYCRYSTALLINE ALUMINIUM DURING THERMAL CYCLING.
G.Wyon, J.M.Marchin and P.Lacombe.
C.R. Acad. Sci. (France), Vol. 252, No. 10, 1467-9 (March 6, 1961). In French.

Previous work by the authors [Revue de Métallurgie (France), No. 6, 549 (1959)] has shown that the repeated heating and cooling of polycrystalline aluminium does produce a simplification of the substructure network. The present work is a careful study of the kinetics of this process and the various factors that influence it. R.Bullough

9110 ANOMALOUS GROWTH OF MoO_3 CRYSTALS. E.Yoda.
J. Phys. Soc. Japan, Vol. 15, No. 5, 821-9 (May, 1960).

The growth from the vapour phase in air and in oxygen gas wa studied optically, and an extraordinary growth mechanism was found. The vapour impinging upon a surface did not crystallize directly, but instead it passed through a liquid state before crystallization. The liquid consists of MoO_3 and MoO_3', the latter being a new phase probably related to the polymerization of MoO_3 vapou or the liquid structure of MoO_3. The lattice parameters of MoO_3' were estimated from the X-ray data. The origination and stability of the liquid phase were discussed briefly, and it was ascertained that this crystallization mechanism accelerates remarkably the growth rate of the crystal. Also the anisotropy of surface migration of the vapour molecules absorbed on the crystal surface analysed. The migration velocity of absorbed molecules is about 1.5 times larger in the c-direction than in the a-direction of MoO_3 crystal, and hence the morphology of closed loop steps was accounted for.

9111 GROWTH AND EVAPORATION OF TUNGSTEN OXIDE CRYSTALS.
F.Hashimoto, K.Tanaka and E.Yoda.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1006-14 (June, 1960).

Growth and evaporation processes of crystals formed on a surface of a metallic tungsten filament at elevated temperatures w observed continuously by an electron microscope. In the tempera ture ranges of 700 ~ 1300° C, 1300 ~ 1600° C and 1600 ~ 1800° C, needle crystals, lump-like crystals and thin films were grown up respectively, but they soon disappeared by evaporation, and above 2000° C, no crystals were grown. The effect of preliminary heati of the specimen filament in air on the crystal growth was also ascertained. It became clear that the material needed for crystal growth was supplied from the vapour phase, and a simple relation between growth rate and needle diameter was obtained.

9112 SPIRAL FORMATION ON NATURAL CRYSTALLINE SULPHUR. S.H.Emara.
Nature (GB), Vol. 190, 254-5 (April 15, 1961).

A description is given of growth spirals originating from scre dislocations on the (001) faces of natural sulphur crystals. The step heights, measured interferometrically, range from 100 to 5000 A. Dislocation density varies from a few to 10^4 per cm^2, and on any crystal face spirals are predominantly of one hand. S.Tolansky

9113 GROWTH SPIRALS ON SYNTHETIC MAGNETOPLUMBITE CRYSTALS. R.A.Lefever and A.B.Chase.
Nature (GB), Vol. 190, 255-6 (April 15, 1961).

Growth spirals on the (0001) faces of tabular magnetoplumbite ($PbFe_{12}O_{19}$) are described. Step heights appear to be small multip of the unit cell in the c-direction. Interferometric techniques are used to measure steps and heights of 48 and 68 A are recorded. A partial reversal in curvature is described. Both right- and left-handed spirals are found on a given surface. A tightly wound mult step spiral of step 163 A is described. Dissociation of the steps takes place. S.Tolansky

9114 AIR BUBBLES IN ICE. A.E.Carte.
Proc. Phys. Soc. (GB), Vol. 77, Pt 3, 757-68 (March, 1961).

The opacity of ice formed from water containing dissolved air is due to the presence of bubbles of air in the ice. Both bubble concentration and sizes were found to depend on the rate of freezing Bulk water saturated with air at 0° C was found to freeze into ice containing about six bubbles per mm^3 when freezing proceeded at 0.5 mm min^{-1} and 300 per mm^3 at a rate of 5 mm min^{-1}. Bubbles were formed at the ice—water boundary when the concentration of dissolved air reached a critical value which, for rates of freezing greater than 2 mm min^{-1}, corresponded to a supersaturation ratio of 30. Agitation of the water could prevent the critical concentration from being attained and clear ice then formed. Other factors which influenced bubble concentrations and sizes were the amount of dissolved air, pressure, thickness of the layer of water ahead of the growing ice and escape of bubbles by buoyancy. The magnitude

extent of the air concentration gradient ahead of the ice were mated from theory. Bubbles in ice were found to change shape time particularly when under the influence of a temperature lient.

9115 THE GROWTH OF DISLOCATION-FREE SILICON SINGLE CRYSTALS. G.Ziegler.
Naturforsch. (Germany), Vol. 16a, No. 2, 219 (Feb., 1961). erman.
Si single crystals were grown by the pedestal method from ly thick seeds with dislocation densities of about 10^4 cm^{-2}. The ocations, decorated with Cu, were generally oriented in the] and [211] directions, and occasionally in the [111] direction. locations disappeared in the growing crystal, because thermal in at the growth front was small, and the rate of crystal growth fast compared with the glide velocity of the dislocations.
J.Franks

9116 N- AND P- TYPE SINGLE CRYSTAL BISMUTH TELLURIDE. A.C.Yang and F.D.Shepherd.
lectrochem. Soc. (USA), Vol. 108, No. 2, 197-8 (Feb., 1961).
These crystals were grown by the Czochralski method from erials of five nines purity. Slag formation was minimized by ing under hydrogen. Pull rates were 0.2 to 20 cm/hr. Stoichio- ric melts yielded p-type crystals while the addition of Cu_2Te ded n-type crystals at pull rates < 0.5 cm/hr. At pull rates cm/hr dendritic crystals were produced, the growth direction g 2130. However there was no visible evidence of the twin e formation observed in dendritic cubic crystals.
W.Bardsley

9117 INDUCTION HEATED PRESSURE VESSEL FOR GROWING OXIDE SINGLE CRYSTALS.
erretti, D.G.Wickham and A.Wold.
sci. Instrum. (USA), Vol. 32, No. 5, 566-8 (May, 1961).
An induction-heated oxygen-pressure vessel was constructed row ferrite crystals under sufficient oxygen pressure to mize their decomposition. The furnace is capable of operation 600° C and 75 atm pressure.

9118 FILAMENTARY CRYSTALS GROWN FROM THE SOLID METAL. G.Sines.
Phys. Soc. Japan, Vol. 15, No. 7, 1199-1210 (July, 1960).
A theoretical analysis and experimental evidence show that a rce of energy for spontaneous whisker growth is the elastic in energy arising from the anisotropy of thermal expansion. ervation of whisker growth on a Bragg bubble raft suggests the growth mechanism could be by cooperative repetitive rement of dislocations. The conditions for whisker growth from solid are presented and by fulfilling them, growths were pro- ed on gold, silver, bismuth, lead, indium, and lead-indium alloys. crystallographic orientations of a number of tin whiskers are orted, one of which had a transition between two orientations ough it was straight. The tensile strengths of several tin skers were measured and observed to be lower than calculated n bending tests. The high elastic strain of 5% in bending was erved for an indium one.

9119 THE HYDROTHERMAL GROWTH OF MOLYBDENA WHISKERS ON MoO_3–SiO_2 SUBSTRATE.
Callahan, R.H.Petrucci and C.A.Brown.
olloid Sci. (USA), Vol. 15, No. 5, 418-26 (Oct., 1960).
The following growth variables were studied: steam pressure, perature, MoO_3 concentration, silica surface area, molybdenum ation state, and the effect of added metal oxides. The diffusion oO_3 over silica films was also investigated. An hypothesis for nechanism of the transport and whisker growth processes is ulated. Transport is believed to be a surface process which rs via a slightly stable silicomolybdic acid-like complex. De- position of the surface complex with deposition of MoO_3 at pre- ed surface sites is believed to result in the observed whisker th.

9120 ON THE YELLOW COLOURING OF LITHIUM FLUORIDE CRYSTALS. J.Eckstein, M.Holas, J.Jindra, chytilová and Z.Wachtl.
ch. J. Phys., Vol. 10, No. 3, 247-54 (1960).
In agreement with other authors, the conclusion is reached that uring is caused by impurities. Selective absorption in the infra- region at 2.8 μ is independent of this colouring. Analytical data e supplemented by crystal growing experiments in which defined admixtures of heavy metals, such as Co, Mn, Fe, Cr, Ni, Pt, Cu were added to the melt. It is shown that, of the admixtures used, the most intense colouring is produced by manganese. Experiments on the effect of Cu and Pt were not entirely conclusive. In vacuum colour-producing impurities evaporate quite easily from the melt until their concentration drops below the critical limit required for colouring; in air this happens only if the charge is left in the melted state for a longer period (in the present case a 1 kg charge was kept at 100° C above melting point for 36 hr). Results are improved if a dried gas, for instance nitrogen, is bubbled through the melt. A colourless crystal can be obtained in this manner even without using a vacuum; the starting material, however, must be sufficiently pure. A new method was evolved for preparing the salt by direct precipitation of LiCl and HF. Heavy metals are removed from the lithium component by means of cupral and dithizone. The construction of the apparatus used for the crystal growing experiments in vacuum is new.

CRYSTAL LATTICE STRUCTURES

9121 PRINCIPLES OF X-RAY CRYSTALLOGRAPHY. [Principes de radiocristallographie]. J.Barraud.
Paris: Masson et Cie (1960) xi + 236 pp. In French.
An introduction to the techniques used in X-ray crystal analysis, particularly directed to biologists and medical scientists. The book has four parts which deal with the following topics: (1) the general principles of the crystalline state including a discussion of symmetry (25 pp.); (2) elements of optics as they relate to interference and diffraction phenomena (39 pp.); (3) the techniques of X-ray crystal analysis, including single crystal and powder methods, the use of crystal monochromators and small-angle scattering; a description of the application of the techniques to crystalline material and to paracrystalline substances (112 pp.); (4) some results obtained from the application of X-ray crystal analysis to nucleic acids, proteins and viruses, with a discussion of the importance of this branch of science in biology (18 pp.). There are numerous diagrams and reproductions of typical X-ray diffraction patterns. A bibliography (10 pp.) of books and original papers is included. J.Iball

9122 WAVELENGTH DISTRIBUTION OF X-RAYS IN THE FOCUS OF A [JOHANSSON] MONOCHROMATOR AND AN ESTIMATE OF THE INFLUENCE OF THIS DISTRIBUTION ON PRECISION MEASUREMENTS OF LATTICE CONSTANTS.
J. Čermák.
Czech. J. Phys., Vol. 10, No. 3, 215-24 (1960).
The distribution is computed assuming that the tube focus emissivity $G(\alpha)$, reflection curve $R(\alpha)$ and wavelength distribution of the incident radiation $J(\lambda - \lambda_0)$ are known. It is shown, for example, that the centre of gravity may be shifted in accordance with the position of the crystal on the focal circle, which may considerably influence precision measurements of lattice parameters.

9123 MULTIPLE-ANODE PROPORTIONAL COUNTER X-RAY DIFFRACTOMETER. J.Chikawa.
J. Phys. Soc. Japan, Vol. 15, No. 4, 602-11 (April, 1960).
Argon-filled and xenon-filled three-anode proportional counters were designed so as to attain a quantum counting efficiency of about 90% for CuK and MoK α-radiation, respectively. Important properties of these counters are compared with those of NaI(Tl) scintillation counters. These proportional counters have remarkable superiority over NaI(Tl) scintillation counters in monochromatization effect upon the characteristic radiation in use of a pulse-height analyser, though their quantum counting efficiencies for the characteristic radiation are almost the same. A stabilizer of X-ray tube output utilizing an ionization chamber with balanced filters as a monitor was also constructed. High stability was attained without accurate regulation of the tube voltage.

9124 A DEVICE FOR ORIENTING SINGLE CRYSTALS BY X-RAY DIFFRACTION. V.Andresciani and G.Schippa.
Ricerca sci. (Italy), Vol 30, No. 8, 1172-7 (Aug., 1960). In Italian.
Describes a goniometer device, designed for orienting semiconductor crystals, for use in conjunction with an X-ray source and a Geiger counter. A.R.Stokes

9125 CRYSTAL ROTATOR FOR CRYOSTAT.
R.H.Webb and R.B.Griffiths.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 303-4 (March, 1961)

9126 AMORPHOUS LEAD LACQUER FOR X-RAY DIFFRACTION. J R.Doig, Jr and C.M.Schwartz.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 354-5 (March, 1961).

Describes the use of lead naphthenate for masking out undesired areas of X-ray diffraction specimens. A.R.Stokes

9127 DETERMINATION OF ACCURACY IN MEASURING THE PARAMETERS OF TETRAGONAL AND HEXAGONAL LATTICES. M.Černohoský.
Czech. J. Phys., Vol. 10, No. 3, 225-32 (1960).

The procedure for determining the accuracy when measuring the parameters of tetragonal and hexagonal lattices is described. The accuracy can easily be calculated for all common methods by means of graphically represented functions. The relations derived can be used as quantitative criteria for the suitability of the combination of lines from which the lattice parameters are to be determined.

9128 ABSORPTION CORRECTIONS FOR THE PRECESSION METHOD. S.W.Kennedy and J.H.Patterson.
Rev. sci. Instrum. (USA), Vol. 32, No. 5, 564-5 (May, 1961).

A means is presented of making absorption corrections graphically for the zero level in X-ray diffraction photography with the precession camera.

9129 A MICROWAVE ANALOGUE FOR X-RAY DIFFRACTION I. EFFECT OF THE CRYSTALLITE SIZE
G.B.Mitra and G.S.Sanyal.
Indian J. Phys., Vol. 34, No. 3, 103-6 (March, 1960).

Diffraction of X-rays by a crystal is analogous to that of microwaves by a three-dimensional array of scatterers when the distance of one scatterer from another is of the same order of magnitude as the wave lengths of the microwaves. To verify this, metallic scatterers in the form of small cylinders were arranged to form a model of a crystal having tetragonal lattice parameters of a = 3.2 cm and c = 4.8 cm. A lattice of 900 such unit cells was irradiated by microwaves of wavelength 3.2 cm. Bragg's law was found to be valid for the (100) and (110) planes of this crystal model. The intensity distribution curves around these two reflection maxima were studied for 10, 7 and 4 planes in the b-direction. The half intensity widths were compared with the formula due to Scherrer (1918). The formula was found to agree fairly well with the experimental data.

9130 X-RAY STUDY OF NEUTRON IRRADIATED BARITE ($BaSO_4$). J.M.Luthra and V.M.Padmanabhan.
J. sci. industr. Res. (India), Vol. 19B, No. 10, 406-7 (Oct., 1960).

Studies on the X-ray line broadening of the neutron irradiated barite crystal revealed that the broadening is due to strain in the lattice rather than to particle size. The imperfections are found to be along (001) planes separated vertically by a distance of 1100 A.

9131 CRYSTAL TEXTURE OF LiF SINGLE CRYSTALS BY X-RAY TECHNIQUE. H.Nimura.
J. Phys. Soc. Japan, Vol. 15, No. 2, 231-9 (Feb., 1960).

Using the convergent X-ray beam method with a transmission-type monochromator, the crystal texture of as-grown LiF single crystals was studied for thick as well as thin specimens. It was found that the topographic as well as the goniometric information is obtainable on a diffraction photograph by the use of a convergent incident beam. Observation of surface texture was also carried out by an etching method to interpret the fine structure of the diffraction pattern more thoroughly.

9132 AN APPARENT PARADOX IN CRYSTAL STRUCTURE ANALYSIS. G.N.Ramachandran and R.Srinivasan.
Nature (GB), Vol. 190, 159-61 (April 8, 1961).

An example is given in which the amplitudes of a structure A were used with the phases of a structure B to produce a Fourier synthesis which had peaks of electron density resembling those of B, and not those of A. This does not contradict the usual method of structure refinement by successive Fourier syntheses, however, because structure B did not resemble A at all. It is also discussed in terms of deconvolution of Patterson diagrams. A.R.Stokes

9133 TWO-DIMENSIONAL FOURIER TRANSFORM TECHNIQUE FOR ANALYSING RANDOM STRUCTURES. D.M.C.MacEwan and H.H.Sutherland.
Nature (GB), Vol. 190, 431 (April 29, 1961).

A two-dimensional form of MacEwan's method of analysis of periodicities (Abstr. 5221 of 1953) is illustrated by an application to a complex of vermiculite with $C_6H_{13}NH_2$. A.R.Stokes

9134 SINGLE CRYSTAL DIFFRACTION PATTERN OF GERMANIUM.
R.Bubáková, J.Drahokoupil and A.Fingerland.
Czech. J Phys., Vol. 10, No. 3, 255 (1960).

Rocking curves were obtained with the three-crystal spectrometer of Renninger (Abstr. 10080 of 1955) using germanium crystals of high perfection, in order to make comparisons with the dynamical theory of reflection. A.R.Stokes

9135 NEUTRON DIFFRACTION INVESTIGATIONS OF METALLIC CERIUM AT LOW TEMPERATURES.
M.K.Wilkinson, H.R.Child, C.J.McHargue, W.C.Koehler and E.O.Wollan.
Phys. Rev. (USA), Vol. 122, No. 5, 1409-13 (June 1, 1961).

Neutron diffraction experiments were performed on metallic cerium at a series of temperatures between room temperature and 4.2°K in an attempt to clarify the anomalous behaviour which has been observed in previous specific heat and magnetic susceptibility measurements. Results on three specially prepared samples show that the interesting magnetic behaviour can be correlated with the three crystallographic phases present in the samples. There is a change in the electronic configuration of the cerium atoms when the collapsed face-centred cubic phase is formed, and antiferromagnetic ordering occurs in the hexagonal close-packed phase at about 12.5°K.

CRYSTAL STRUCTURE OF THE β AND γ FORMS OF He^4.
See Abstr. 8279

9136 CRYSTAL STRUCTURE OF MONOCLINIC TUNGSTEN TRIOXIDE AT ROOM TEMPERATURE. S.Tanisaki.
J. Phys. Soc. Japan, Vol. 15, No. 4, 573-81 (April, 1960).

The crystal structure of tungsten trioxide at room temperature was studied by the X-ray oscillation method. The crystal has a monoclinic unit cell with a = 7.30 A, b = 7.53 A, c = 7.68 A and $\beta = 90°54'$, containing eight molecules of WO_3. c axis length is twice that reported by other authors. The space group is $P2_1/n$. The structure analysis was performed by trial and error based on inspection of the Patterson projections along a and c axes. The arrangement of tungsten atoms is similar to the structure reported by Braekken (1931). The positions of oxygen atoms, which had been determined hitherto mainly from packing considerations, could be obtained directly from the weak reflections with odd index l. According to the structure obtained, the crystal is antipolar in the directions of a, b, and c axes.

9137 THE CRYSTAL STRUCTURE OF META-ZEUNERITE $Cu(UO_2)_2(AsO_4)_2 \cdot 8H_2O$. F.Hanic.
Czech. J. Phys., Vol. 10, No. 3, 169-81 (1960).

The tetragonal unit cell, having the dimensions a = 7.10$_5$ A and c = 17.70$_4$ A, contains two structure units of $Cu(UO_2)_2(AsO_4)_2 \cdot 8H_2O$. The space group is $P4_2/nmc$. The distribution of the atoms in the unit cell was determined from the Patterson projection P(vw) and by means of $(F_o - F_c)$ synthesis. Meta-zeunerite has a layer type structure. The sheets $[(UO_2)(AsO_4)]_\infty$ are separated by layers containing the cations $(Cu(H_2O)_4)^{2+}$ and molecules of water. The uranium is coordinated octahedrally with six oxygen atoms at distances: U—O_1 1.94 A, U—O_2 1.78 A, U—$O_{3(4)}$ 2.18 A (4×). The uranyl radical O_1—U—O_2 is linear. In the tetrahedron AsO_4 the interatomic distances are As—O 1.77 A and the bond angles 102°, 102°, 113° and 113°. Each oxygen atom of the tetrahedron AsO_4 is simultaneously bonded to the uranium atom. The bond angle As—O—U is 137°. The layers $[(UO_2)_2(AsO_4)]_\infty$ are bonded together by the cations $(Cu(H_2O$. The distances Cu—O_1 and Cu—O_2 are 2.55 and 2.58 A, respectively. The structural changes during hydration and dehydration are explained.

9138 THE CRYSTAL STRUCTURE OF COPPER DIPYRIDINE DIBROMIDE $Cu(C_5H_5N)_2Br_2$. V.Kupčík and S.Durovič.
Czech. J. Phys. Vol. 10, No. 3, 182-90 (1960).

An X-ray structural analysis was carried out. The substance is monoclinic, its space group is $P2_1/n$, having the lattice constants a = 8.30 kXU, b = 17.72 kXU, c = 4.04 kXU, $\beta = 96°$. Z = 2. The localization of the heavy atoms was carried out by means of the projections of the Patterson functions P(u, v) and P(v, w), which provided the bases for determining the signs of the majority of structure factors. The projections of the electron density $\sigma(x, y)$ and $\sigma(y, z)$ were calculated on the basis of these data. The positions of the atoms were refined three times by methods of differential syntheses and by geometrical analysis. The structure of $CuPy_2Br$ is very close to that of $CuPy_2Cl_2$ differing from it primarily in the

entation of the symmetry elements with respect to the crystallo-phic axes. In both structures the copper atom is octahedrally coordi-ed with four halogen and two nitrogen atoms. The nitrogen atoms and bromine atoms are bound to the copper covalently in the struc-e of the bromine derivative, as follows from the length of the ds (Cu–N 1.99 kXU, Cu–Br, 2.46 kUX), while the remaining two mine atoms are bound to the copper by weaker bonds and mediate chain formation of molecules in the direction of the c axis.

9139 THE CRYSTAL STRUCTURE OF KETTNERITE, $CaBi[OF|CO_3]$. V.Syneček and L.Žák.
ech. J. Phys., Vol. 10, No. 3, 195-207 (1960).
Macroscopic, microscopic, goniometric, qualitative spectro-phic and quantitative chemical data of kettnerite with some new ervations are given. The unit cell dimensions determined from powder and rotating crystal photographs are $a_0 = b_0 = 5.36 \pm 0.02$ A, = 13.59 ± 0.03 A. There are four molecules in the unit cell. The stal structure of kettnerite was studied from the ordinary and eralized projections of the Patterson function along the [010] s. Direct evidence of tetragonal layers (Ca, 2F, Ca) and 2O, Bi) parallel to the basal face was found. The spatial angement of these layers corresponds to the symmetry of the ce group P 4/nmm. These layers alternate in the [001] direction ng interleaved by single CO_3 layers. Both the biaxial character he mineral and the uncertainty concerning the rotation of the groups indicate a lower, most probably an orthorhombic sym-try. The highest possible symmetry is that of Cmma. The struc-e is related to that of the type X_1 found by Sillén et al. (1942) for eral bismuth oxyhalides and especially to that of bismutite.

9140 A CONTRIBUTION TO THE CRYSTAL STRUCTURE OF $Cu(NH_3)_4(NO_3)_2$. M.Karavičová and J.Madăr.
ech. J Phys., Vol. 10, No. 3, 258 (1960).
Orthorhombic; a = 10.79; b = 23.62; c = 6.88 kX; Z = 8; space-up Pnn2 or Pnnm. x- and y-coordinates of copper ions are en. A.R.Stokes

9141 A CONTRIBUTION TO THE CRYSTAL STRUCTURE OF $KHSeO_4$. J.Madăr.
ech. J Phys., Vol. 10, No. 3, 259 (1960).
Orthorhombic; a = 10.04, b = 19.41, c = 8.68 kX, Z = 8; space-up Pbca. Structure is similar to $KHSO_4$; some atomic coordinates given. A.R.Stokes

9142 DIRECT OBSERVATION OF CRYSTAL LATTICES OF COPPER AND PLATINUM PHTHALOCYANATES WITH ELECTRON MICROSCOPE. H.Espagne.
Phys. Radium (France), Vol. 21, No. 2, 97-101 (Feb., 1960).
French.
Images were obtained on which it is possible to measure the cings between the crystal planes and to observe dislocations in crystal lattice.

STRUCTURE OF LUMINESCENT PRODUCTS BASED ON LCIUM FLUORIDE AND ANTIMONY OXIDE. See Abstr. 9003

9143 STATISTICAL STRUCTURE OF ANTHRONE. K.Banerjee and S.N.Srivastava.
an J. Phys., Vol. 34, No. 4, 184-6 (April, 1960).
The space group of anthrone has been found [Ibid, Vol. 31, 12, 644 (Dec., 1957)] to be $P2_1/a$ with 2 molecules per unit cell. s requires a molecular centre of symmetry. The chemical mulae of an anthrone molecule does not possess any centre of metry. In the rotation photographs of an anthrone crystal about symmetry axis, diffuse blackenings occur midway between layer s. These are also corroborated by diffuse blackenings in appro-ite positions in Weissenberg photographs. A statistical structure n anthrone crystal is proposed in order to explain these apparent malies.

ALLOYS . METALLURGY

9144 ELECTRICAL RESISTIVITY AND STRUCTURE OF THE COBALT–TUNGSTEN CARBIDE ALLOYS.
V.F.Funke, A.N.Shurshakov, S.I.Yudkovskii, K.F.Kuznetsova, V.I.Shulepov and Yu. N. Yurkevich
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 2, 207-15 (Aug., 1960). In Russian.
The pseudo-binary system Co–WC was studied by X-ray diffraction, metallographic examination, and measurements of the electrical resistivity of specimens, sintered at 1200°C and either oil-quenched or furnace-cooled to room temperature. The results indicate that 0.5% Co is sufficient to destroy the continuity of the network of WC grains. No evidence was found of solubility of Co in WC at temperatures ≥1250°C; the solubility of WC in Co at 1200°C was 12-13 wt.%. It is shown that the decrease in the plasticity of the Co layers, separating the WC grains, is associated with the distorted lattice of a thin Co layer at the Co–WC interface. M.H.Sloboda

9145 CRYSTALLOGRAPHIC INVESTIGATION OF SOME IRON–RHODIUM ALLOYS.
F.de Bergevin and L.Muldawer.
C.R. Acad. Sci. (France), Vol. 252, No. 9, 1347-9 (Feb. 27, 1961). In French.
The transition from antiferromagnetism to ferromagnetism in alloys near equiatomic composition (Abstr. 445 of 1939) is accompanied by an increase of the lattice constant of the ordered body-centred cubic lattice. E.P.Wohlfarth

9146 STUDY ON THE ORDERED ALLOYS OF GOLD–MANGANESE SYSTEM BY ELECTRON DIFFRACTION. I. Au_3Mn.
D.Watanabe.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1030-40 (June, 1960).
The structure was investigated using oriented, evaporated films. The structure can be thought of as formed from the fundamental face-centred orthorhombic lattice, in which the atoms arrange themselves as in the ordered lattice of Cu_3Au, but the first kind of out-of-step periodicity occurs along both the x and y directions. In some cases the periods are 1.2 a_1 and 2.2 a_2 respectively, where $a_1 = 4.08$A, $a_2 = 4.05$A, $A_2 = 4.03$A are the lattice constants of the fundamental lattice. Thus, a two-dimensional anti-phase domain structure of a new type takes place, which belongs to the space group P_{nnm}-D_{2h}^{12} in the idealized case.

ELECTROLUMINESCENCE AND CRYSTAL STRUCTURE IN THE ALLOYS SYSTEM ZnS--CdS. See Abstr. 9012

9147 Zn:Tl PHASE DIAGRAM AT VERY LOW THALLIUM CONCENTRATIONS. E.H.McLaren and F.Weinberg.
Canad. J. Phys., Vol. 39, No. 4, 588-95 (April, 1961).
The Zn–Tl liquidus was accurately determined from pure Zn (419.505°C) to the monotectic transition temperature (416.926°C at 0.42 at.% Tl) using precision resistance thermometry. The upper solidus was determined approximately from measurements of the distribution coefficient (~0.01) and the solid solubility limit (~0.004 at.% Tl) of thallium in zinc. A value 1.53 ± 0.1 kcal/mole for the latent heat of fusion of pure zinc was calculated from the freezing point depressions.

9148 DETERMINATION OF THE DEGREE OF SHORT-RANGE ORDER IN MULTI-COMPONENT DISORDERED SOLID SOLUTIONS. A.N.Men'.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 145-8 (July, 1960). In Russian.
A method of determining the degree of short-range order is developed which is more accurate than that due to Cowley (Abstr. 5177 of 1950), since it takes into account not only the distance between, but also the distribution of atoms in the intermediate coordination spheres. M.H.Sloboda

9149 ONE-DIMENSIONAL ORDER–DISORDER MODEL WHICH APPROACHES A SECOND-ORDER PHASE TRANSITION. G.A.Baker, Jr.
Phys. Rev. (USA), Vol. 122, No. 5, 1477-84 (June 1, 1961).
The calculation of the partition function for a simple one-dimensional order–disorder model is reduced to the solution of a certain functional equation. This equation is solved rigorously and it is shown that in the limit of indefinitely long-range interactions the model exhibits a finite discontinuity in the specific heat.

9150 A THEORY OF ORDER–DISORDER PHENOMENA. I.
F.E.J.Kruseman Aretz and E.G.D.Cohen.
Physica (Netherlands), Vol. 26, No. 11, 967-80 (Nov., 1960).

A moment due to Kirkwood for the computation of the occupation probabilities of a pair of nearest neighbour sites in an order–disorder system is generalized in a systematic way to larger figures of sites in the lattice. The general theory is given and formal expressions for the moments are derived.

9151 A THEORY OF ORDER–DISORDER PHENOMENA. II.
F.E.J.Kruseman Aretz and E.G.D.Cohen.
Physica (Netherlands), Vol. 26, No. 11, 981-96 (Nov., 1960).

On the basis of a moment method developed in the preceding abstract, several well-known approximation methods: the method of Guggenheim and McGlashan (Abstr. 5132 of 1951), Yang (Abstr. 2575 of 1945) and Li (Abstr. 1894 of 1950), and of Kikuchi–Hijmans–De Boer (Abstr. 4263 of 1949; 5134 of 1951; 784 of 1952; 7715-17 of 1955), are rederived by restriction to the first moment. Furthermore, using the second- and third moment, explicit expressions for the semi-invariants $\lambda_{2i}L$ and $\lambda_{3i}L$ are given for the case that the interaction is restricted to pairs of nearest neighbours.

9152 THE RATE OF ATTAINMENT OF EQUILIBRIUM IN THE COOLING OF ALLOYS. M.J.Druyvesteyn.
Physica (Netherlands), Vol. 27, No. 4, 406-12 (April, 1961).

The deviations from equilibrium are calculated for a simplified case. Vacancy diffusion is assumed to be the rate determining process. The cases of vacancy concentration, short range order of the atoms and precipitation are calculated for a stepwise way of cooling and for a constant cooling rate. For short range order, the surplus of vacancy concentration after quenching is important for the attainment of equilibrium. For precipicitation, however, it is unimportant for the cases assumed in the calculations.

OTHER SOLID FORMS

9153 THE ENERGY SPECTRUM OF AN AMORPHOUS SUBSTANCE. P.Phariseau.
Physica (Netherlands), Vol. 26, No. 12, 1185-91 (Dec., 1960).

A Green's function method is used for the energy spectrum of an electron moving in a one-dimensional model of an amorphous solid consisting of atoms of the same kind, each represented by a Dirac's δ-function. The integration of the Schrödinger equation is reduced to the integration of a linear and homogeneous equation of the second order. Using a continued fraction method, the existence of allowed energy bands in amorphous solids is proved. Moreover, extra localized energy levels in the forbidden energy regions are obtained.

9154 PROTON MAGNETIC RESONANCE AND X-RAY DIFFRACTION STUDIES OF POLYPROPYLENE.
A.Nishioka, Y.Koike, M.Owaki, T.Naraba and Y.Kato.
J. Phys. Soc. Japan, Vol. 15, No. 3, 416-28 (March, 1960).

Crystalization and glass transition in various samples of polypropylene were studied by proton magnetic resonance over the wide temperature range -180 to 200°C, and by X-ray diffraction at room temperature. It was found that the free rotation of methyl groups would be hindred below -130°C and the second moment tended to increase towards the rigid state value. Motional narrowing occurs gradually at -40°C in atactic polymer which is mostly amorphous. On the other hand, isotactic polymer which is highly crystalline, showed rather sharp narrowing from -10 to 30°C, but the condition of heat treatment affected the behaviour of narrowing. X-ray diffraction patterns suggest that quenched film has smaller size of crystallite than that of annealed film. The line shape of an atactic polymer is very similar to that of amorphous component decomposed by the Wilson–Pake method in an isotactic polymer, and then the degree of crystallinity of a highly crystalline isotactic sample was estimated about 70 ~ 80% at room temperature. When the isotactic polymer was cooled down from 200°C, recovery of crystallization was observed between 140 and 120°C.

9155 RE-APPRECIATION OF THE SECOND ORDER TRANSITION PHENOMENA IN POLYETHYLENE.
R.Nakane.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1040-8 (June, 1960).

The phenomena are discussed based on a dilatometric measurement. Calculating the value $(V_1 - V_0)/(V_2 - V_0)$ from the result of measurement on three samples, each having different crystallinity it is found that the crytallinity of polyethylene changes with temperature above -30°C. Also the transition at -55°C is found, below which the expansion coefficient of the crystalline phase becomes equal to that of the amorphous phase, and this phenomenon is thought to be the true second order transition. The crystallinity of each sample is calculated by using the method of Hoffmann and Weeks [J. Res. Nat. Bur. Stand. (USA), Vol. 60A, No. 5, 465-80 (May, 1958)] as the first approximation and applying some further calculation. The application of the least-mean-square method the calculation of transition by means of the electronic computor is attempted.

9156 STEREOSPECIFIC POLYMERS AND MARKOFF CHAINS. T.B.Grimley.
Proc. Phys. Soc. (GB), Vol. 77, Pt 4, 931-6 (April, 1961).

If the only factors restricting the configurations of a polymer molecule are the constancy of the C–C–C bond angle, and the existence of a potential hindering free rotation about C–C bonds, stereospecific polymers of the type $(CHX)_N$ are simple Markoff chains but the stereospecific vinyl polymers $(CH_2CHX)_N$ are not. These vinyl polymers are examples of Markoff chains with a periodic transition probability. The eigenvalue theory of such chains is briefly discussed.

9157 THE ROLE OF GRAIN BOUNDARY MOTION IN THE LAST STAGE OF SINTERING. J.Hornstra.
Physica (Netherlands), Vol. 27, No. 3, 342-50 (March, 1961).

This stage is governed by the diffusion of vacancies from the pores to grain boundaries. The precipitation of the vacancies at the boundaries causes elastic stresses, which make the rate of precipitation uniform over the boundary area. This is not true when the grains are sliding along the boundary and the boundary is suitably curved. Then most vacancies can precipitate in the neighbourhood of the pores and the rate of sintering will be higherthan in the case of a plane boundary. This shows that plastic deformation can play a role in sintering, although vacancy diffusion remains the most important process. The dislocation model of grain boundaries is used to illustrate the role of vacancy diffusion in grain boundary motion. The dependence of the overall rate of sintering on the pore size distribution is given.

Surfaces . Films . Adsorption

9158 INVESTIGATION OF SOME PHYSICAL PHENOMENA TAKING PLACE ON THE SURFACE OF CRYSTALLINE SOLIDS AT ELEVATED TEMPERATURES. IV. CALCULATION OF THE KINETICS OF "SELF-HEALING" OF ARTIFICIALLY PRODUCED DEFECTS ON THE SURFACE OF SOLIDS.
Ya.E.Geguzin and I.O.Kulik.
Fiz. Metallov i Metallovedenie, Vol. 9, No. 3, 379-84 (March, 196
In Russian.

Formulae are derived which describe the process of self-healing of a surface scratch of simple geometry (isosceles triang in cross-section) by the mechanism of surface diffusion and volatilization/condensation. The relative part played by these two mechanisms is given by the coefficient $\gamma = t^D_{1/2}/t^C_{1/2}$, where $t^D_{1/2}$ and $t^C_{1/2}$ are the half-times of self-healing by the mechanism of surface diffusion and volatilization/condensation, respectively. It is shown that $\gamma \cong P_0 l^2/(mkT)^{1/2} n D_S$, where P_0 is the vapour pressure, l the width of the scratch, m the atomic mass, k Boltzmann's constant, T the absolute temperature, n the surface atomic density and D_S the surface diffusion coefficient. Assuming $D_S \cong 10^{-5}$ cm^2/sec, $n \cong 10^{15}$ and $l \cong 10^{-4}$ cm, the following values of γ were obtained for several metals near their m.p.: 10^{-4} for Cu, 10^{-3} for Ag and Ni, and 10^{-6} Au.
M.H.Sloboo

9159 INVESTIGATION OF SOME PHYSICAL PHENOMENA TAKING PLACE ON THE SURFACE OF CRYSTALLINE SOLIDS AT ELEVATED TEMPERATURES. V. THE PROCESS OF SELF-HEALING OF ARTIFICIALLY PRODUCED SURFACE DEFECTS IN POLYCRYSTALLINE COPPER.
Ya.E.Geguzin and N.N.Ovcharenko.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 569-77 (April, 1960). In Russian.

The process of self-healing of scratches, made with a diamond pyramid indenter (136°) on the surface of polycrystalline, O-free Cu, was studied on specimens held at 600, 700, 850 and 950°C in an atmosphere of H, A or Cu vapour, by following the change of the profile of the scratch with the aid of a light interferometer. The manner in which the profile of a scratch changed depended on the

face condition of the specimen and on the orientation of the stals relative to the specimen surface. The coefficients of sure diffusion in Cu, calculated from the data on the kinetics of the cess studied, were in good agreement with those determined by er methods. It was postulated that the surface layer, deformed ing the grinding and polishing operations, is finely-crystalline stable at high temperature, the latter property having been ributed to the absence of coherent bond between the adjacent stallites. M.H.Sloboda

9160 WHAT HAPPENS DURING THE POLISHING OF GLASS. A.Kaller.
aer Jahrbuch (Germany), 1959 I, 181-210. In German.

An attempt is made to elucidate the details of the processes of h-polishing and felt-polishing of glass with the help of electron roscope photographs. A measure of the effectiveness of a given ishing medium is defined, and it is investigated how this varies h the type of glass, the load on the polishing head, and different ishing media. Finally an attempt is made to explain theoretically y cerium oxide is such a superior polishing medium.

D.M.Schlapp

9161 CONTRIBUTION TOWARDS THE UNDERSTANDING OF PROCESSES OCCURRING DURING THE ELFCTRO-TIC POLISHING OF METALS. R.Zetzsche.
aer Jahrbuch (Germany), 1959 II, 300-60. In German.

A series of investigations on several common metals and alloys, ticularly into the properties of the anodic layer of the electrolyte. addition to the electrical measurements, optical observations rect microscopic and schlieren technique) during polishing were de, and the effects of ultrasonic fields were studied. Two types surface layer are recognised, and the polishing effect is discussed erms of layer formation and removal, and the electrical and chanical properties of the layers. H.Mykura

9162 DEVICE FOR EVAPORATING MULTIPLE FILMS. G.M.Androes, R.H.Hammond and W.D.Knight.
. sci. Instrum. (USA), Vol. 32, No. 3, 251-5 (March, 1961).

A description is given of the construction and operation of a ice which is capable of producing multiple layers of evaporated ns. Uniform strands of a metal and of a dielectric are alternately into bits, which are evaporated completely, the size of each bit ermining the thickness of the corresponding layer. Each layer metal may be continuous, or divided quite uniformly into small ticles, depending on the conditions of the experiment. In the er instance, the result may be a rather concentrated mono-persed colloid. The preparation of a specimen containing 000 layers of tin, approximately 40 A thick, and constituting of the total volume, is described. Evaporated nylon has been nd to be a satisfactory insulator between the layers of metal; lar film, 0.00025 in. thick, works very well as a substrate. eral other uses for the evaporating machine are suggested.

9163 THE PHYSICAL ADSORPTION OF HYDROGEN ON POLYETHYLENE AND TEFLON. W.Thompson.
ysica (Netherlands), Vol. 26, No. 11, 890-916 (Nov., 1960).

Adsorption was studied at temperatures between 14° and 20°K l pressures between 0 and 20 microns of Hg. From the adsorp- isotherms the differential heats and entropies of adsorption re determined. Surface areas were evaluated by applying the unauer–Emmett–Telle theory to adsorption measurements with n at 14°K. The maximum surface coverage studied was about monolayer or less. No significant difference between the orption of para and normal H_2 was found with these adsorbents. Para H_2 was used in most of the measurements. Polyethylene appears to be a slightly better adsorbent for H_2 than is Teflon. A difference of about 4% in the corresponding heats of adsorption will account for the results. This is consistent with estimates of the attractive Van der Waals potential between a H_2 molecule and a $-CH_2-$ or $-CF_2-$ group, calculated form the equation of Kirkwood and Müller. The differential isosteric heat of adsorption decreases with increasing surface coverage for both adsorbents. The range measured was from about 800 to 450 cal/mole. There is some temperature dependence, particularly for polyethylene. The differential entropy (S_{ads}) of adsorbed para H_2 was determined, although with considerable experimental uncertainty. At the surface coverages studied here, S_{ads} appears to increase rapidly with coverage, a fact which may be related to the corresponding decrease in the differential heat of adsorption. S_{ads} shows considerable temperature dependence for both adsorbents. In an appendix, the method is described by which the large thermomolecular pressure differences present in these studies are evaluated. The method involves making measurements with connecting tubing of successively smaller diameter and extrapolating to zero tube diameter. The limiting equation $P_1/P_2 = \sqrt{T_1/T_2}$ can then be applied.

SURFACE ELECTRICAL CHANGES CAUSED BY THE ADSORPTION OF HYDROGEN AND OXYGEN ON SILICON.
See Abstr. 8948

MICROSTRUCTURE EXAMINATION

(By X-rays and Electron and Other Microscopes)

9164 AN ELECTRON-MICROSCOPE INVESTIGATION OF GRAIN GROWTH DURING RECRYSTALLIZATION OF PLASTICALLY DEFORMED ALUMINIUM FOIL.
G.Hasse and F.Granzer.
Naturwissenschaften (Germany), Vol. 47, No. 10, 223-4 (1960). In German.

Electron-diffraction photographs before and after annealing of a 100 A thick, deformed aluminium foil showed no change of lattice orientation; this supports Cahn's theory (Abstr. 5319 of 1950).

J.E.Caffyn

9165 A KINEMATICAL THEORY OF DIFFRACTION CONTRAST OF ELECTRON TRANSMISSION MICROSCOPE IMAGES OF DISLOCATIONS AND OTHER DEFECTS.
P.B.Hirsch, A.Howie and M.J.Whelan.
Phil. Trans A (GB), Vol. 252, 499-529 (May 5, 1960).

Describes a theory of images observed in thin crystalline foils. The contrast is essentially phase contrast in the Bragg diffracted beams, the differences being due to the displacements of the atoms from their positions in the ideally perfect crystal. The theory explains many of the characteristic features of the observed images, such as the dependence of the contrast on orientation, the reversal of contrast on bright and dark field images, the fact that dislocations are generally dark on bright field images, the position and width of the images, the general nature of the profile, the occurrence of dotted dislocations, the invisibility of some dislocations, the dependence of contrast on the inclination of the dislocation, and the occurrence of double images. The theory also accounts satisfactorily for the nature and width of the dislocation images obtained with X-rays.

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

9166 EXCHANGE OF ZINC IN POLYCRYSTALLINE ZINC OXIDE. E.A.Secco.

Disc. Faraday Soc. (GB), No. 28, 94-102 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961).

The exchange of zinc vapour with polycrystalline zinc oxide was measured under different conditions of temperature and zinc pressures. At 0.25 atm zinc pressure and s = 0.45 (mole fraction of zinc in solid), the exchange data can be fitted to a first-order rate law with the Arrhenius expression given by

$$k_e = 6.4 \times 10^8 \exp(-56.0\,\text{kcal/RT})\text{sec}^{-1};$$

the rate-determining step is the elementary exchange reaction. The exchange rate was observed to increase with reaction fraction suggesting an autocatalytic reaction. In terms of an autocatalytic reaction the Arrhenius equation is expressed by

$$k_e = 4.6 \times 10^5 \exp(-39.5\,\text{kcal/RT})\text{sec}^{-1}.$$

At 0.14 atm zinc pressure and s = 0.60, the exchange data show a rapid initial process, the phase-boundary reaction, expressed by

$$k_e = 4.3 \times 10^5 \exp(-40.5\,\text{kcal/RT})\text{sec}^{-1},$$

which is followed by a slower process, probably diffusion-controlled. These results are discussed in the light of existing data on the exchange and diffusion of zinc in zinc oxide and the oxidation of metallic zinc.

9167 LITHIUM KINETIC ISOTOPE EFFECT IN THE REACTION OF ETHYLLITHIUM WITH BENZYL CHLORIDE. R.West and W.Glaze.

J. chem. Phys. (USA), Vol. 34, No. 2, 685-6 (Feb., 1961).

The reaction, the products of which are n-propylbenzene and lithium chloride, follows second-order kinetics (first-order in each reactant). Using C_2H_5Li containing approximately equal amounts of Li^6 and Li^7 it was established that after allowing the reaction to proceed to half completion, enrichment of Li^6 in the LiCl and Li^7 in the unreacted ethyllithium had taken place. The observed effect, k_6/k_7, was 1.029 ± 0.008. A maximum effect of 1.07 was calculated from the results of measurements of infrared absorption bands of the ethyllithium compounds. Suggestions are made concerning the mechanism of the reaction. W.Good

9168 BIS-LIGANDED NITROSYL AS A REACTION INTERMEDIATE. J.R.Cox, Jr and J.D.Ray.

J. chem. Phys. (USA), Vol. 34, No. 3, 1072-3 (March, 1961).

Investigation by quantitative infrared spectroscopy of the gas phase reaction of NOCl and CH_3OH leads to the conclusion that the reaction is second order in CH_3OH and first order in NOCl and, obversely, from transition state theory, that the reverse reaction is first order in CH_3OH as well as in CH_3ONO and in HCl. A reaction scheme is formulated which involves the assumption of a bis-liganded reaction intermediate. A detailed discussion is given in support of this assumption. W.Good

DECOMPOSITION OF AMMONIUM PERCHLORATE ON SUBLIMATION. See Abstr. 8261

9169 MEASUREMENT OF PARTICLE AND GAS TEMPERATURES IN A SLIGHTLY LUMINOUS PREMIXED FLAME. R.C.Millikan.

J. Opt. Soc. Amer., Vol. 51, No. 5, 535-42 (May, 1961).

Particle and gas temperatures were independently measured above a 7.0 cm diam. flat, premixed ethylene–air flame. The mixture ratio (F/A = 0.144) and gas velocity (10 cm/sec N.T.P.) were chosen to yield a faintly luminous flame in which soot deposition occurred far from chemical equilibrium. Thus, heat input to the particles due to surface chemical reaction was as large as possible consistent with accurate measurement. Soot cloud emission was measured relative to a tungsten lamp between 4138 and 10 000 A. The soot cloud extinction was similarly measured for an approximate flame path of 50 cm. Soot particles, sucked through a small quartz probe, were caught in vacuum on a cool electron microscope target. The particles were about 100 A across at the 6 mm level, growing to 400 A at 12 mm above the burner. The particle temperature, derived from the spectral distribution of the soot cloud emis was found to be 1714 ± 60° K at the 12 mm level. The gas tempera measured by the Na D-line reversal method, was 1775 ± 20° K. Chemiluminescent effects were absent. It is concluded that even i this case where the particle size was one-tenth the mean free pat and where the particles were being heated by surface reaction, th particle temperature equals the gas temperature within the quote limits of uncertainty.

MICROWAVE DETERMINATION OF ELECTRON CONCENTR TIONS IN FLAME GASES. See Abstr. 8234

9170 IGNITION OF n-HEXANE-AIR MIXTURES IN SHOCK WAVES. K.Terao.

J. Phys. Soc. Japan, Vol. 15, No. 6, 1113-22 (June, 1960). In German.

The ignition lag was measured under different conditions, in order to analyse its fluctuations statistically. The probabilities o ignition of the mixtures were thus calculated. The ignition was considered to consist of two steps: the initiation reaction and the secondary reaction. The activation energies of both these steps were calculated in each case. These values were then used in an attempt to explain some aspect of the mechanism of ignition.

9171 STABILIZATION OF LATTICES BY SORBED AND INCLUDED MOLECULES. R.M.Barrer.

J. Phys. Chem. Solids (GB), Vol. 16, No. 1-2, 84-9 (Nov., 1960).

The method of solution thermodynamics is developed to give the changes in chemical potential, enthalpy and entropy of a solid which has adsorbed or included volatile or non-volatile constituer The method is illustrated by determinations of changes in chemic potential when water, ammonia or fluorocarbons are imbibed by porous crystals of faujasite, or when hydrocarbons are intercalat by alkylammonium clays. It is shown that all sorbates including inert gases can stabilize lattices in which they are occluded, but that among volatile "guest" molecules the stabilization is most substantial in the case of well established mineralizers such as water. Since many minerals (e.g. zeolites, clays, scapolites, sodalites, cancrinites) contain included water or salts these materials must play an important role in catalysing the growth of the "host" lattice. This catalysis which is an important part of solid state chemistry is now shown to rest in part upon a thermodynamic basis.

ELECTROCHEMISTRY

9172 SINGLE PULSE METHOD FOR MEASUREMENT OF ELECTRICAL DOUBLE LAYER PARAMETERS. J.S.Riney, G.M.Schmid and N.Hackerman.

Rev. sci. Instrum. (USA), Vol. 32, No. 5, 588-92 (May, 1961).

An electric analogue of an electrochemical cell is assumed to consist of a constant ohmic resistance, representing the bulk electrolyte, and a parallel combination of resistance and different capacity, representing one interface. The response of the model a rectangular current–time function is given in terms of circuit components. The interface parameters are not assumed to be constant and the equations yield instantaneous values for each of them. A pulse generator is described, which is capable of closel approximating the required current–time function. Results of measurements made on Pt and dropping Hg are presented.

PHOTOCHEMISTRY RADIATION CHEMISTRY

9173 ROOM TEMPERATURE STABILIZATION OF RADIATION-PRODUCED FREE RADICALS IN BITURIC ACIDS. J.A.R.Cloutier.
ad. J. Phys., Vol. 39, No. 4, 514-33 (April, 1961).
Experimental evidence showed that a boric acid glass may be to stabilize at room temperature organic free radicals pro-ed by radiation in a number of barbituric acid derivatives. The hod and the experimental results are discussed.

9174 PHOTOLYSIS OF NITROUS OXIDE. I. 1236 A. J.P.Doering and B.H.Mahan.
hem. Phys. (USA), Vol. 34, No. 5, 1617-20 (May, 1961).
The photolysis of nitrous oxide containing an N^{15} atom in the rnal position was investigated using 1236 A-light. The products ude N_2^{29}, $N^{15}O$, $N^{14}O$, and small amounts of N_2^{30}. The appearance $_2^{30}$ shows that there are two primary processes occurring at this elength, one of which is dissociation to a nitrogen atom and a ic oxide molecule, the other dissociation to an oxygen atom and a ygen molecule. The latter process is approximately 10 times as ortant as the former. The quantum yield of nitrogen is ± 0.04.

9175 RADIOLYSIS OF CYCLOHEXANE. II. CYCLOHEXANE —CYCLOHEXENE SOLUTIONS AND PURE LOHEXENE. G.R.Freeman.
ad. J. Chem., Vol. 38, No. 7, 1043-52 (July, 1960).
For Pt I, see Abstr. 14134 of 1960.

9176 RADIOLYSIS OF CYCLOHEXANE. III. VAPOR PHASE. J.M.Ramaradhya and G.R.Freeman.
hem. Phys., (USA), Vol. 34, No. 5, 1726-9 (May, 1961).
The radiolysis of cyclohexane vapour by Po^{210} α-particles was investigated. The Po^{210} source was calibrated by ferrous-sulfate dosimetry, using $G(Fe^{+++}) = 5.5$. The product yields were studied as a function of dose. The initial yield for hydrogen was $G(H_2)_i = 8.0$. The fraction volatile at -112°C, consisting of C_2, C_3, and C_4 hydrocarbons, had an initial G value of 4.9 ± 0.5. The poor agreement in material balance is tentatively ascribed to ion—molecule reactions, since ions formed during radiolysis have a life-time of the order of 10^{-3} sec. The value of the ratio C(cyclohexene)/(dicyclohexyl) = 1.67 is similar to that found in liquid cyclohexane radiolysis. The G values for various types of cyclohexane fragmentation are also given.

DISPERSIONS . COLLOIDS

9177 THE STUDY OF EMULSIONS BY MICROSCOPY AND DIFFRACTION. I. COMPLETED STUDIES.
R.M Delgado.
An. Real. Soc. Espan. Fis. Quim. (Spain), Vol. 55(A), No. 11-12, 283-94 (Nov.-Dec., 1959). In Spanish.
The light microscope (phase-contrast and polarizing), the electron microscope, and electron diffraction were used to study alpechin (juice from olives) in various states. Photographs are reproduced. A.R.Stokes

9178 STUDY OF EMULSIONS BY MICROSCOPY AND DIFFRACTION. II. THE INTERPHASE MEMBRANE.
R.M.Delgado.
An. Real. Soc. Espan. Fis. Quim. (Spain), Vol. 55(A), No. 11-12, 295-304 (Nov.-Dec., 1959). In Spanish.
See preceding abstract. A discussion of the structure of the membrane surrounding oil droplets in the emulsion obtained from olives is based on microscopy and Debye—Scherrer diagrams.
A.R.Stokes

THEORETICAL INVESTIGATIONS ON THE LIGHT SCATTERING OF COLLOIDAL SPHERES. See Abstr. 8239

GEOPHYSICS

9179 TORSIONAL OSCILLATIONS OF THE EARTH. H.Takeuchi.
phys. J. (GB), Vol. 4, 259-75 (1961).
Making use of the variational calculus method developed in a vious paper (Abstr. 10404 of 1959), the free periods of torsional llations are calculated for two earth models. In the Model 1, earth is assumed to be composed of homogeneous mantle and core. he Model 2, the mantle structure model by Jeffreys and Bullen sed. In order to see the dependence of the periods on the core dity, the periods when the core is fluid or perfectly rigid are ulated. In the fluid core model, the periods when the coupling veen the mantle and core is perfect or zero are worked out. e-period observations must be accurate to within about 30 secs useful core-rigidity information.

EFFECT OF INTERSTELLAR GRAVITATIONAL RADIATION VIBRATIONS OF THE EARTH. See Abstr. 8040

9180 ATMOSPHERIC EXCITATION OF THE EARTH'S WOBBLE. W.Munk and El Sayed M.Hassan.
phys. J. (GB), Vol. 4, 339-58 (1961).
Hassan (1960) has computed mean monthly values of the atmo-ere's moments and products of inertia for the period 1873 to), using all available station-level pressures. On the basis of e time series the excitation of the seasonal and 14 month ndler) wobble is discussed. With respect to the seasonal wobble, calculations confirm the conclusion by Jeffreys and others that it ue largely to atmospheric excitation. By working directly with ion-level pressures the procedure followed previously of re-ing the sea-level correction from sea-level pressure charts was ded (thus "uncorrecting" for a large and undesirable correction). amplitudes are 25% smaller than those given by Jeffreys (1959). With respect to the Chandler wobble, it has been suggested by Jeffreys (1940), Rudnick (1956), and by Munk and MacDonald (1960) that this represents a resonance amplification of the irregular (non-seasonal) variation in atmospheric inertia. The computed spectral density of the atmospheric variation at the Chandler frequency falls short by one to two orders of magnitude to meet the requirements of this hypothesis. Excitation by irregular motion in the core is briefly considered. Here the electromagnetic coupling (limited by conductivity in the lower mantle) appears to be far too weak to account for the observed wobble. The excitation of the Chandler wobble must be considered an unsolved problem.

IRREGULARITIES IN EARTH'S ROTATION DUE TO GEOMAGNETIC WESTWARD DRIFT. See Abstr. 7950

9181 THE EARTH'S GRAVITATIONAL POTENTIAL, DEDUCED FROM THE ORBITS OF ARTIFICIAL SATELLITES. D.G.King-Hele.
Geophys. J. (GB), Vol. 4, 3-16 (1961).
Describes the relevant methods, cursorily reviews previous results, and gives details of a fresh determination of the second, fourth and sixth harmonics in the earth's gravitational potential from the orbits of Sputnik 2, Vanguard 1 and Explorer 7.

9182 PROPAGATION OF RAYLEIGH WAVES IN THE EARTH. Z.Alterman, H.Jarosch and C.L.Pekeris.
Geophys. J. (GB), Vol. 4, 219-41 (1961).
The propagation was investigated in the whole range of periods T from about 10 sec up to 1 hr. Three methods were necessary in order to cover this range of periods effectively. The standard "flat Earth method", with neglect of gravity, gave values for the phase velocity C correct to within 1% up to T = 50 sec only, and for the

group velocity U up to T = 250 sec. The method of the "flattening of the Earth", with neglect of gravity, has the 1% accuracy limits for C and U at 300 and 400, respectively. Inclusion of gravity effects in the flattening of the Earth approximation does not alter the above limits. For T > 300 (n < 25) the period T(n) of free oscillation of the Earth had to be determined as a function of the order of the spherical harmonic n. This involved the solution of a system of differential equations of the sixth order, in which the gravitational effects were included. The wave penetrated appreciably into the core already at T = 600. Using the above three methods in their respective ranges of validity, C(T) and U(T) were evaluated for (1) Bullen's Model B, (2) the Jeffreys–Bullen Model, as modified by Dorman, Ewing and Oliver, and (3) the Gutenberg Model. The observed Rayleigh group velocity data of Ewing and Press for T < 380 sec and the phase velocity data of Nafe and Brune for T < 300 sec agree with the values computed for the Gutenberg model, but not for the other models. This substantiates a previous conclusion reached by Takeuchi, Press and Kobayashi and by Dorman, Ewing and Oliver that the observed Reyleigh wave data provide evidence in support of Gutenberg's low-velocity layer. The few observed Rayleigh group velocities between T = 400 and 600 are substantially lower than the theoretical values for all the three models.

ATMOSPHERE

(Troposphere and Stratosphere)

9183 AN INVESTIGATION OF PSYCHROMETER. II. Y.Ômori.
J. Phys. Soc. Japan, Vol. 15, No. 4, 706-18 (April, 1960).

For Pt I see Abstr. 4040 of 1954. Experiments were carried out to determine precisely the psychrometer constant A for dry and humid air in the temperature range of $0^\circ \sim 40^\circ$C. The results were compared with a theoretical formula derived by the use of the analogy between the transfers of heat and mass by which A is represented to be proportional to $(C_p\rho D/K)^n$. Experimental values of A are found to be about 4% larger than the theoretical value obtained by taking, as usual, n = 0.3. The deviation is minute, but better agreement can be obtained by adopting the value of 0.5 for n. Experiments were also carried out to examine effects on A of various factors such as atmospheric pressure, size of pyschrometer, ventilation and conditions of supercooling or freezing of wet-bulbs, obtaining good agreement with the theory.

ATMOSPHERIC EXCITATION OF THE EARTH'S WOBBLE.
See Abstr. 9180

9184 QUESTION OF THE POLARIZATION OF INFRARED RADIATION FROM THE CLEAR SKY.
H.E.Bennett, J.M.Bennett and M.R.Nagel.
J. Opt. Soc. Amer., Vol. 51, No. 2, 237 (Feb., 1961).

Details are given of an infrared analyser made up from silver chloride plates which was used to measure to within 2½% the polarization of radiation from the clear sky at right angles to the sun in the sun vertical. In the visible region of the spectrum the polarization was 60% but for wavelengths greater than 2μ it was less than 2½%. These results support the theory that radiation from the clear sky in the visible and near infrared is scattered and polarized but at larger wavelengths it originates from atmospheric emission and should not be polarized. H.G.Jerrard

9185 GREEN FLASH. R.E.Seebold.
J. Opt. Soc. Amer., Vol. 51, No. 2, 237 (Feb., 1961).

The "flash" was seen in quite unusual circumstances, namely, by diffuse reflection of the light of the setting sun from the exhaust trail of a high-flying aircraft. Time of passage along the length of the trail was 1-2 sec. D.R.Barber

9186 EVALUATION OF ATMOSPHERIC AEROSOL PARTICLE SIZE DISTRIBUTION FROM SCATTERING MEASUREMENTS IN THE VISIBLE AND INFRARED. J.A.Curcio.
J. Opt. Soc. Amer., Vol. 51, No. 5, 548-51 (May, 1961).

The atmospheric aerosol particle size distribution was examined using measured spectral scattering coefficients in the wavelength region 0.40-2.27 μ. It was found that the aerosol on a particular day can be represented by a two-component composite, the main component having a Junge distribution of the form dN/d logr = Cr-n and the other having either a distribution of larger particles similar to that of aerosols found in maritime air or a relatively monodisperse distribution contained in a narrow radius interval. This study shows that estimates of aerosol size distribution may be in error is based only on attenuation measurements in the visible region.

9187 TRANSMISSION AND SCATTERING PROPERTIES OF A NEVADA DESERT ATMOSPHERE.
M.G.Gibbons, J.R.Nichols, F.I.Laughridge and R.L.Rudkin.
J. Opt. Soc. Amer., Vol. 51, No. 6, 633-40 (June, 1961).

The angular-scattering diagram was obtained for radiant energy of 0.40, 0.45, 0.50, and 0.55 μ wavelength, and attenuation coefficients for scattering and absorption have been determined in the same atmosphere for radiant energy of 0.40, 0.50, 0.70, and 0.83 μ wavelength. The ratio of scattered-in to direct radiant flux received from a 4π source has been measured for receiver fields of view ranging from 4° to 64° half-angle and for source-receiver distances ranging from 0.51 to 13.17 m. By extrapolation of the results to the case of a receiver with field of view of 90° half-angle attenuation coefficients for aureoled transmission from a 4π source to a flat receiver facing the source have been determined.

9188 MEASUREMENT OF ATMOSPHERIC TRANSMISSIVITY USING BACKSCATTERED LIGHT FROM A PULSED LIGHT BEAM. M.H.Horman.
J. Opt. Soc. Amer., Vol. 51, No. 6, 681-91 (June, 1961).

Concerns the use of pulsed light sources of extreme luminance and short duration in measuring the transmissivity of the air along a slant path; the glide approach path to an airport runway is of particular interest. The fundamental pulsed-light-transmissometer technique is described for an idealized atmosphere and an idealized single-ended transimissometer (confocal transmitter and receiver). Complications arising from real conditions are avoided by the following modified technique: A transmitter on the ground projects a series of light pulses up the glide path, during which time a receiving system separated to the side collects light scattered from the transmitter beam at each of a sequence of predetermined ranges and plots the scattered light flux received against time. These return plots are graphically superimposed on a single time base and an envelope of the return peaks is drawn. Equations representing individual returns indicate that their peak envelope can be used to determine the transmissivity at any given range and the average transmissivity over a given path. Signal variations due to clouds and absorbing media are discussed, and the use of the technique in a ceilometer is mentioned. Path length limitations due to equipment features and to secondary scatter under low-transmissivity conditions are discussed. Measurements obtained with an experimental pulsed-light transmissometer are given and compared with measurements by two other systems.

9189 STUDY OF THE TRANSMISSION OF LIGHT BY MIST AND FOG. A.Arnulf, J.Bricard, E.Curé and C.Veret.
Rev. Opt. (France), Vol. 38, No. 3, 105-33 (March, 1959).
In French.

UPPER ATMOSPHERE IONOSPHERE

(See also Space Research. Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

9190 STRUCTURE OF THE THERMOSPHERE. M.Nicolet.
Planet. Space Sci. (GB), Vol. 5, No. 1, 1-32 (Jan., 1961).

The vertical distribution of the density in the thermosphere, deduced from satellite observations, must be explained by an increase of the scale height with altitude. A varying gradient of the scale height cannot be interpreted by assuming an increase of the temperature gradient with altitude. An examination of the interrelationship between the absolute values of density in a dark atmosphere and diurnal conditions of heat conduction reveals that the varying gradient of the scale height above 200 km is essentially due to the decrease of the molecular weight of the atmospheric constituents subject of diffusion. In the night atmosphere the isothermy above a certain altitude (> 200 km) is the critical factor characterizing the

ical distribution of density. The temperature of the isothermal on, resulting from conduction, is related to the ultraviolet ing which was available during the day. The effect of diffusion been clearly shown by establishing a thermo-isobaric relation necting the temperature of the isothermal region with an isobaric el where atomic oxygen has a specific concentration. From ervational data on the variation of the night-time density at high els, it is possible to deduce the variation of the temperature of isothermal region. The gradient of temperature in a sunlit osphere is related to the fraction of the ultraviolet solar energy orbed, which determines the magnitude of the variation of the e height with altitude. Since heat transport is a function of the nic or molecular concentrations and the square of the distance, shown that anomalies in the temperature gradient cannot be manent.

9191 POLAR IONOSPHERIC DISTURBANCES AND SOLAR CORPUSCULAR EMISSIONS. T.Obayashi and Y.Hakura.
net. Space Sci. (GB), Vol. 5, No. 1, 59-69 (Jan., 1961).

It has been found that the study of polar radio blackouts due to ormal ionization in the lower ionosphere yields considerable dence indicating the existence of energetic solar particles ociated with solar flares. Polar radio blackouts are classified two characteristic types, one is the polar cap blackout and the er is the auroral zone blackout. It is shown that the polar cap ckout appears with some hours delay after a major solar radio burst of type IV, and the blackout is confined within the geo- gnetic latitude of 60^0-65^0. The estimated energies of particles sing this are of about 10-100 MeV. The auroral zone blackout n follows, being accompanied with geomagnetic storms and rae, and it may be caused by the so-called auroral particles of eV or less. The energy spectrum of solar particles associated n solar flares is revealed from the present result together with information from various observations related to solar and restrial disturbances. It is concluded that solar particles have a spicuous suprathermal non-Maxwellian tail extending from a few up to relativistic energy range, though the bulk of corpuscular uds consists of rather low energy particles and hence likely to be he Maxwellian distribution. Some discussions on the nature of ar corpuscular clouds and their effect upon the terrestrial osphere are also given.

9192 THE INDUCTION OF ELECTRIC CURRENTS IN A NON-ISOTROPIC AND NON-UNIFORM IONOSPHERE.
.M.Hanna.
c. Math. Phys. Soc. UAR (Egypt), No. 23, 17-24 (June, 1959).

The study of the distribution of the induced currents in a non- tropic and non-uniformly conducting ionospheric shell for an ernal inducing magnetic potential of period one day, shows a ng of the current lines in the direction of the meridians; also the stence of two systems of vortices, one in the positive distribution current lines and the other in the negative distribution, symmet- ally placed with respect to the equatorial plane. The current is found to lag behind the inducing potential by a quarter of a iod, spherical polar coordinates being used throughout.

LIGHT-CURVES OF 30 SOLAR FLARES IN RELATION TO DDEN IONOSPHERIC DISTURBANCES. See Abstr. 7996

9193 VERTICAL CHARACTERISTICS OF TRAVELLING IONOSPHERIC DISTURBANCES. L.H.Heisler.
tral. J. Phys., Vol. 13, No. 4, 655-64 (Dec., 1960).

The vertical dimensions of travelling disturbances phenomena e investigated by derivation of the associated true height distri- ons of ion density. The height at which they appear often has an er limit which may fluctuate in height from day to day. It ears that direction of travel is related mainly to season, with possibility of some additional form of solar control only evident mes of sunspot maximum. During a particular season, there is bvious change of direction of travel with height in the height ge under observation. No definite variation of speed with height vident in the ionospheric region considered, which extends from to 230 km.

9194 DIRECTION-FINDING ON DIFFUSE SOURCES OF ELECTROMAGNETIC RADIATION. D.G.Cartwright.
tral. J. Phys., Vol. 13, No. 4, 712-17 (Dec., 1960).

It is shown that, for sources of large angular size, the ponse of an Adcock type direction-finder is independent of the nt of the source in altitude. On the other hand, the response rotating loop does depend on altitude. By combining the characteristics of both types of direction-finder, the position and size of an extended source can be found, provided that a brightness profile can be assumed.

9195 RADIO-STAR SCINTILLATIONS AND THE AURORAL ZONE. P.A.Forsyth and K.V.Paulson.
Canad. J. Phys., Vol. 39, No. 4, 502-9 (April, 1961).

A continuous series of observations of scintillations of the radio star, Cassiopeia A, carried out at Saskatoon at a frequency near 53 Mc/s over a period of nearly 4 years was analysed. The altitude-angle dependence of the scintillations was very strong in 1955 but weak in 1958. This behaviour suggests that the scintillations are not produced in a uniform layer of the atmosphere. It seems more likely that the scintillations arise most strongly in regions of the atmosphere closely associated with the auroral zone and that these regions migrate southward during years of intense sunspot activity.

9196 RADIO STAR SCINTILLATION AND MULTIPLE SCATTERING IN THE IONOSPHERE. D.S.Bugnolo.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 1, 89-96 (Jan., 1961).

Recent experimental evidence of radio star scintillation indicates that multiple scattering effects are of importance in the ionosphere. It is therefore of interest to apply the transport equation for the expectation of the photon density function to this problem. The solution of the transport equation is used to predict the mean-squared scattering angle and corresponding size of the ionospheric irregularities as measured on the earth. The particular example discussed in detail is based on a Gallet model for turbulence in the underside of the F layer under night-time conditions. However, it should be noted that the general theoretical results can be applied to any other model.

THE DESIGN AND CAPABILITIES OF AN IONOSPHERIC RADAR PROBE. See Abstr. 8015

9197 AMPLITUDE SCINTILLATION OF RADIO STAR AT ULTRA-HIGH FREQUENCY. H.C.Ko.
Proc. Inst. Radio Engrs (USA), Vol. 48, No. 11, 1871-80 (Nov., 1960).

Observations at 915 Mc/s over a 12-month period (October 1957-September 1958) are described. By daily observations of Cygnus A (IAU 19N4A) over a wide range of elevation angles, both the amplitude and rate of scintillation were studied. It was found that the amplitude scintillation is strongest near the horizon and decreases rapidly as the altitude increases. The amount of the intensity fluctuation ranges from less than 3% to over 50% of the undisturbed intensity, while the rate of fluctuation varies from $\frac{1}{2}$ to 8 peaks/min. A fluctuation amplitude greater than 10% was observed at low-altitude angles for 71% of the total observations. The frequency of occurrence of scintillation follows a seasonal variation having two maxima: one in the winter and the other in the summer. During these two maximum periods, the mean fluctuation amplitude was found to be higher than during other periods. It was also found that the mean fluctuation rate in the winter is about three times faster than that in the summer. It was also observed that the scintillation characteristics are markedly affected by the presence of auroras or geomagnetic disturbances, or both. During the winter months, the fluctuation rate is roughly proportional to the three-hour geomagnetic K index.

9198 THE ELECTRON CONTENT AND DISTRIBUTION IN THE IONOSPHERE. T.G.Hame and W.D.Stuart.
Proc. Inst. Radio Engrs (USA), Vol. 48, No. 10, 1786-7 (Oct., 1960).

More exact ionospheric data require greater night-time values of the "electron distribution ratio" (ratio of number of electrons above the F2 peak to that below) than those previously given [Abstr. 4470B of 1960; Proc. Inst. Radio Engrs (USA), Vol. 48, No. 1, 364-5 (March, 1960)] to be increased. Over the period March 21 to April 13, 1959, three major decreases in $N_{max}F2$ are also evident in total electron content data up to the height of satellite 1958 δ2 (Faraday rotation measurements). Two of these coincide with the occurrence of magnetic storms, while the third does not.

G.M.Brown

9199 DIURNAL VARIATION OF F_1 REGION DRIFTS AT WALTAIR. E.Bhagiratha Rao and B.Ramachandra Rao.
Current Sci. (India), Vol. 30, No. 1, 9-10 (Jan., 1961).

Horizontal drift velocities were measured by the "spaced-receiver" method, using frequencies reflected from the F_1 layer at virtual heights of 230 to 260 km. In general, the drifts are south-westerly during most of the day, but north-easterly in the morning

and evening: their magnitudes are not given. See also Abstr. 6464 of 1960. H.Rishbeth

9200 ON THE F_2-REGION OF THE IONOSPHERE. S.Datta.
Indian J. Phys., Vol. 34, No. 2, 66-74 (Feb., 1960).

Calculations of the total electron production rate in a column of unit cross-section extending from the "bottom" to the maximum electron density height and of the mean production rates in different parts of the F_2-region are made with the help of the attachment coefficient model suggested by Radcliffe et al.(Abstr. 7870 of 1956). It is found that the results are consistent with those expected from the hypothesis of Bradbury (1938) for the formation of the F2-region. The calculations are made by the method suggested by the author (Abstr. 10413 of 1959).

EFFECTS OF EQUATORIAL SPREAD-F IRREGULARITIES ON C.W. TRANSMISSIONS. See Abstr. 8393

9201 PHOTOMETRIC OBSERVATIONS OF 5577 Å AND 6300 Å AIRGLOW DURING THE I.G.Y. R.A.Duncan.
Austral. J. Phys., Vol. 13, No. 4, 633-7 (Dec., 1960).

Twenty-one months' observation of the airglow from near Sydney, Australia, shows that (a) aurorae are detected 10^0 above the southern horizon at 6300 A whenever the magnetic disturbance index (K) reaches 5 but K must reach 7 before detection is certain at 5577 A; (b) the 6300 A zenith intensity increases rapidly with K once this equals or exceeds 4, but the 5577 A zenith intensity is independent of magnetic disturbance; (c) the zenith intensity of 5577 A tends to be a maximum at 03 hr local time; (d) the zenith intensity of 6300 A drops rapidly from dusk till 01 hr and then rises till dawn.

9202 THE SPECTRUM OF THE POLAR AURORA. I. ATOMIC IDENTIFICATIONS. C.Arpigny.
Mem. Soc. Roy. Liege (Belgium), Coll. in-4, Vol. 2, 2-3, 5-30 (1960). In French.

All possible assignments of atomic features in the spectrum of the aurora are critically discussed in the light of modern auroral spectra, and the best available laboratory and theoretical data. R.W.Nicholls

9203 THE SPECTRUM OF THE POLAR AURORA. II. MOLECULAR IDENTIFICATIONS. L.Remy-Battiau.
Mem. Soc. Roy. Liege (Belgium), Coll. in-4, Vol. 2, No. 2-3, 31-78 (1960). In French.

All possible assignments of molecular features in the spectrum of the polar aurora are critically discussed in the light of modern auroral spectra, laboratory and theoretical data. R.W.Nicholls

9204 MODELS OF AURORAL IONIZATION. I. AURORAL IONIZATION MODELS AND THEIR RADIO-REFLECTION CHARACTERISTICS. D.R.Moorcroft.
Canad. J. Phys., Vol. 39, No. 5, 677-94 (May, 1961).

Although radio observations of aurora contain information about the nature of the reflecting ionization, the use of dissimilar models of auroral ionization has led different workers to widely differing conclusions. In this paper several general models of auroral ionization are developed. By considering the ionization as an assembly of individual scatterers, a unified treatment of both weak scattering and critical reflection is included. This treatment is intended to provide a basis for resolving some of the difficulties in the interpretation of auroral radio observations.

9205 MODELS OF AURORAL IONIZATION. II. APPLICATIONS TO RADIO OBSERVATIONS OF AURORA. D.R.Moorcroft.
Canad. J. Phys., Vol. 39, No. 5, 695-715 (May, 1961).

The available experimental evidence concerning radio reflections from aurora is examined in relation to the reflection characteristics of the models of auroral ionization discussed in Pt I. The existence of critical reflection from auroral ionization at frequencies between 30 and 50 Mc/s appears to be established. This implies electron densities as great as 3×10^{13} electrons/m^3. It is shown that the observations are consistent with a model consisting of irregularities ionization elongated parallel to the earth's magnetic field in a ratio of between 5 and 10 times, and having sizes transverse to the field lines of the order of a few metres. Some of the observations require the irregularities to be distributed in size. It is clear that there is a need for more relevant measurements on radio reflections from aurora to specify the characteristics of the ionization more precisely

9206 STUDIES OF AURORAL ECHOES. I. L.Harang and J.Trötim.
Planet. Space Sci. (GB), Vol. 5, No. 1, 33-45 (Jan., 1961).

The drift of the auroral ionization in an E-W direction was studied by means of auroral echoes on a frequency of 40 Mc/s. T identical channels, with aerials at a certain divergence symmetric to north, were used. The crossing over of the blobs, giving receding and approaching ranges on the records was studied, and the E-W drift measured. Two series of observations were made, at Kjelle (60^0 N) and at Tromsö (70^0 N). The mean diurnal curves of E-W motions at these two places are given. The diurnal variation at Kjeller is similar to the drifts recorded at Jodrell Bank. At the auroral station Tromsö the drifts are more irregular. These is a prevailing westerly drift between 17.00 hr-24.00 hr MET and an easterly drift between 24.00 hr-05.00 hr MET. Examples of drift effects using interferometers are shown. The angle of arrival of auroral echoes was studied at Kjeller and Tromsö by an interfere method. The aerial, used both for transmission and reception, sli up and down a mast, and the interference fringes between the dire and the reflected ray measured. The angle of arrival, lying in the interval 6^0-20^0, shows the same dependence of range at Kjeller an Tromsö. The height of the auroral ionization was determined and the aspect sensitivity for reflection studied. The angle of arrival of E_S-propagated ground scatter was measured and is shown to ha about twice the value of the angle of arrival of the auroral echoes

GEOMAGNETISM

9207 SOME EVIDENCE OF HYDROMAGNETIC WAVES IN THE EARTH'S MAGNETIC FIELD. M.Sugiura.
Phys. Rev. Letters (USA), Vol. 6, No. 6, 255-7 (March 15, 1961).

Observations with rapid-run magnetometers provide evidence of the elliptical polarization of magnetic waves; the waves are interpreted as transverse hydromagnetic waves generated in the outer atmosphere and propagated along the lines of magnetic force. R.A.New

9208 GEOMAGNETIC MICROPULSATIONS. G.R.A.Ellis.
Austral. J. Phys., Vol. 13, No. 4, 625-32 (Dec., 1960).

Describes simultaneous observations at three places ranging from 28^0 S. to 51^0 S. geomagnetic latitude. It is shown that there is no observable change in the micropulsation period with latitude although there is a monotonic increase in the amplitude with latitu for all periods between 10 and 100 sec. The interpretation of thes results in terms of existing theories is discussed.

9209 THE MAGNETIC SECULAR VARIATION INTERPRET AS A "ROWLAND EFFECT" ACCOMPANYING ELECTROMAGNETIC INDUCTION PHENOMENA. L.Cagniard.
C.R. Acad. Sci. (France), Vol. 251, No. 19, 2053-5 (Nov. 7, 1960). In French.

If the electrical conductivity in the inter-layer between the earth's core and mantle is assumed to be very high, it is possible explain the general behaviour of the secular variation of the earth magnetic field in terms of a "Rowland effect" varying with the fluctuations in the rotation of the earth. The theory assumes the existence of an electrical double layer at the surface separating the core and the mantle. G.M.Bro

BIOPHYSICS . PHYSIOLOGICAL PHYSICS

9210 CONSTRUCTION AND UTILIZATION OF PRESSURE TRANSDUCERS. E.M.Allard.
ical Electronics Conference, Paris, 1959 (see Abstr. 14326 of
) p. 263-7. In French.
By means of the formulae used in the construction of blood-
sure transducers the important influence of the diameter of the
hragms is indicated, and the construction of an intracardiac
romanometer is described. This instrument includes a
hanical compensation for the temperature effect. The use of
uble diaphragm permits the construction of a differential
romanometer which functions like an intracardiac Pitot tube.

9211 ELECTRON SPIN RESONANCE SPECTRA OF RIBOFLAVIN AND ITS COMPLEXES. M.Sidran.
n. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 283-96
t., 1960).
9th Colloque Ampere Paper (see Abstr. 4734 of 1961).

9212 RESEARCH BY ELECTRON PARAMAGNETIC RESONANCE ON PHOTOSYNTHESIS INGREEN PLANTS.
icolau.
h. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 278-82 (Sept.,
)). In French.
9th Colloque Ampere Paper (see Abstr. 4734 of 1961).

FIBRE OPTICS DUODENOSCOPE AND URETERSCOPE.
Abstr. 8226

RADIALLY GRADED ULTRASONIC RADIATORS TO IMPROVE
E UNIFORMITY OF THE NEAR FIELD. See Abstr. 8193

earing . Speech

9213 FREQUENCY MEASUREMENTS IN SUNG CHORDS.
W.Lottermoser and F.J.Meyer.
stica (Internat.), Vol. 10, No. 3, 181-4 (1960). In German.
By means of a special search-tone analysis, the simultaneous
rvals as sung by famous choirs were measured. There was a
e variation in single tones, major thirds were too wide, minor
ds too narrow, but fifths and octaves were closer to the just
rvals.

9214 SPEECH SYNTHESIS WITH PRERECORDED SYLLABLES AND WORDS. A.N.Stowe and D.B.Hampton.
coust. Soc. Amer., Vol. 33, No. 6, 810-11 (June, 1961).
Lists of Psycho-Acoustic Laboratory sentences were used for
hesis of speech with prerecorded words and syllables as the
ding blocks. The sentences were phonemically transcribed with
able boundaries indicated. The syllables were spoken in a random
er with pauses between each syllable. The words were spoken in
same way without being phonemically transcribed. Two rates,
and fast, were used for each type of building block, making
basic conditions. A different group of eight listeners heard
a condition of synthesized speech. The mean scores, per cent
rect of the five key words in each sentence, for each condition
e: fast rate syllables, 66.6%; fast rate words, 60%, slow rate
ables, 90%; slow rate words, 95.6%.

9215 WORD FREQUENCY EFFECTS IN LEARNING UNKNOWN MESSAGE SETS.
Gerstman and P.D.Bricker.
coust. Soc. Amer., Vol. 32, No. 8, 1078-9 (Aug., 1960).

9216 DESCENT OF THE MEDIAN: REPLY TO GERSTMAN AND BRICKER. H.Rubenstein and I.Pollack.
coust. Soc. Amer., Vol. 33, No. 5, 697-9 (May, 1961).
See Abstr. 6509 of 1960 and preceding abstract. In the presenta-
of an unknown message set in noise, the median word frequency
e incorrect responses is shown to be inversely related to the
ch-to-noise ratio. The hypothesis that this relationship is an
henomenon of increasing knowledge of the message set is re-
ed.

9217 NOTE ON THE POSSIBLE USE OF ULTRASONIC PULSE COMPRESSION BY BATS. G.K.Strother.
J. Acoust. Soc. Amer., Vol. 33, No. 5, 696-7 (May, 1961).
The analogy between echo-location techniques used by bats and those used by radar is extended to the relatively new pulse compression radar technique. The hypothesis that the hearing mechanism of the bat contains a frequency-dependent time delay network permits explanation of most of the anomalies associated with their behaviour, including echo location by pulses which overlap in space.

9218 MECHANISM OF THE MIDDLE EAR. Y.Onchi.
J.Acoust. Soc. Amer., Vol. 33, No. 6, 794-805 (June, 1961).
A mechanical model of the middle ear is obtained from anatomical observations. The differential equations for the model are solved, and the solutions are found in good agreement with the impedance of the ear at the tympanic membrane measured in many ears of fresh cadavers. Thus, the mechanism of the middle ear is clarified theoretically as well as experimentally. The ossicular chain loaded with the impedance of the cochlea is found to be the most important factor controlling the impedance of the tympanic membrane. The ossicular chain has two resonances: the lower one due to the malleoincudal body, and the higher due to the stapes. Thus, the ossicular chain keeps the reactance of the tympanic membrane near or at its resonances. The function of the air cavities behind the tympanic membrane is found to be similar to but less than that of the ossicular chain. The apparent pressure gain by the middle ear for the cochlea is measured. From these data the frequency characteristic of the ossicular chain and the impedance of the stapes are calculated. Moreover, it is found experimentally as well as theoretically that the transmission of the middle ear is not only increased by a lower impedance of the tympanic membrane but also by a higher impedance; transmission is increased by the tympanic membrane vibrating as a rigid cone attached to the ossicular chain even though such attachment increases the impedance of the tympanic membrane.

9219 ON THE SUBDIVISION OF THE AUDIO FREQUENCY RANGE INTO FREQUENCY GROUPS. E.Zwicker.
Acustica (Internat.), Vol. 10, No. 3, 185 (1960). In German.
In recent I.S.O. conferences in Stockholm (1958) and Rapallo (1960), a working group dealt with the problem of "loudness from objective analysis". In the course of their discussions, it was decided to subdivide the frequency range of the human ear (20 c/s to 16 kc/s) into frequency groups having limits of frequency range increasing as the mean-frequency increases. Thus the first group, mean frequency 50 c/s, has limiting frequencies 20 to 100 c/s and bandwidth 80 c/s, whilst the 24th group (the last) has mean frequency 13 500 c/s, limiting frequencies 12 000 to 15 500 c/s and bandwidth 3500 c/s. A table is given which gives these values for each of the 24 sub-divisions of the audio-frequency range. The author suggests that the unit of "tonzahldifference" should be designated "1 Bark" in consideration of the fact that Professor Barkhausen was the author of the first loudness unit. A.B.Wood

9220 LATERALIZATION VERSUS LOCALIZATION. L.A.Jeffress and R.W.Taylor.
J. Acoust. Soc. Amer., Vol. 33, No. 4, 482-3 (April, 1961).
The accuracy with which subjects could assign an azimuth position to a sound coming to them over earphones was studied. The subjects did about as well initially as Stevens and Newman's subjects (1936) did with an external source, and they showed a small amount of improvement with practice.

THE LOUDNESS OF DIRECTIONAL SOUND FIELDS.
See Abstr. 8202

CALCULATING LOUDNESS. See Abstr. 8203

9221 REMARKS ON BIRDSALL'S "DETECTION OF A SIGNAL SPECIFIED EXACTLY WITH A NOISY STORED REFERENCE SIGNAL". R.F.Gundy.
J. Acoust. Soc. Amer., Vol. 33, No. 5, 695-6 (May, 1961).
See Abstr. 14341 of 1960. The existence of an optimum decision procedure for a signal specified exactly with reference

to a noisy stored reference signal is re-examined. It is shown that, within the framework of the theory of signal detectability, no such procedure exists.

9222 INTERVAL OF TIME UNCERTAINTY IN AUDITORY DETECTION. J.P.Egan, Z.Greenberg and A.I.Schulman.
J. Acoust. Soc. Amer., Vol. 33, No. 6, 771-8 (June, 1961).

Three experiments were conducted to measure the decrement in performance that results from uncertainty in the time of onset of a signal presented against a continuous background of noise. The fixed-interval observation experiment was employed. A light defined an observation interval for the listener during which the signal, a tone of 1000 c/s, either was or was not presented [p(SN) = 0.5]. The signal, when presented, started at an instant randomly selected within the observation interval. Thus, the listener was uncertain as to (1) whether or not the signal would occur in the observation interval, and (2) the onset time of the signal, if in fact the signal occurred. The interval of time uncertainty (ITU) during which the tone might start was systematically varied from one series of trials to the next, and the listener knew the duration of ITU in each series. After each observation interval, the listener indicated his confidence that a tone was presented by using a rating scale. Operating characteristics [p(y/SN) against p(y/N)] were plotted on normal-normal coordinates, and measures of detectability were computed. The functional relation between the detectability index d_s and the interval of time uncertainty is presented for each experiment.

9223 MEMORY FOR WAVEFORM AND TIME UNCERTAINTY IN AUDITORY DETECTION.
J.P.Egan, A.I.Schulman and G.Z. Greenberg.
J. Acoust. Soc. Amer., Vol. 33, No. 6, 779-81 (June, 1961).

An experiment was conducted to determine how well listeners could judge whether or not a signal was presented in a noisy observation interval which had already occurred. The cardinal feature of the experiment is that the observation interval is not marked off for the listeners until some fixed time after its occurrence. The listening situation is described as follows. With a probability of 0.5, the signal (1000 c/s, 0.25 sec) is presented at a randomly selected instant. A fixed time thereafter, the listener is informed (by a flash of light) of the real time at which the sinusoid may have occurred, and he responds with a rating of confidence. As compared with the typical fixed-interval experiment in auditory detection, two sources of uncertainty are emphasized in this situation: (1) The listener has a faulty memory of his transformation of the input waveform, and (2) he has a faulty estimation of the time of onset of the signal. From the results of previous experiments on the role of time uncertainty in detection, it appears that a fair portion of the decrement in performance results from poor memory for the input waveform.

9224 BINAURAL HEARING AIDS. AN ENIGMA. J.Jerger and D.Dirks.
J. Acoust. Soc Amer., Vol. 33, No. 1, 537-8 (May, 1961).

Belzile and Markle [Laryngoscope (USA), Vol. 69, 1317 (1959)] reported the intelligibilty superiority of the binaural hearing aid over the monaural aid when listening to speech in noise. They compared a head-mounted binaural aid with a body-mounted monaural aid. The present work repeated the earlier study except that both aids were now mounted on the head; it does not confirm the reported binaural superiority. Indirectly the results support the proposal by Hirsh (Abstr. 5648 of 1950) that supra-threshold PB discrimination in noise will be better for a monaural aid on the head than when on the body. H.D.Parbrook

9225 EXPLORATORY STUDIES ON TEMPORARY THRESHOLD SHIFT FROM IMPULSES.
W.D.Ward, W.Selters and A.Glorig.
J. Acoust. Soc. Amer., Vol. 33, No. 6, 781-93 (June, 1961).

Some exploratory studies of temporary threshold shifts (TTS) induced by acoustic pulses are described. Attempts to determine the effect of pulse rate on TTS were only partially successful because at rates of 1 click/sec or more, residual activity of the protective reflex produced by one click reduced the effective intensity of the next click. The protection induced by this reflex was next examined by using TTS from clicks as the dependent variable; a tone of 1000 c/s at 103 dB SPL, presented to the contralateral ear 105 msec before the click, reduced its effective intensity by about 10 dB. The TTS at 4 kc/s was shown to increase linearly with exposure time; that is, the TTS from pulses is proportional to the number of pulses presented. The average TTS produced by pulses has a broad maximum at 4 kc/s, but this maximum may vary from 2 to 10 kc/s for different observers. Striking individual differences were observed throughout the experiments. Certain aspects of the distortion of pitch that is often correlated with large values of TTS are described.

9226 JUST AUDIBLE THRESHOLDS FOR HARMONIC DISTORTION. M.E.Bryan and H.D.Parbrook.
Acustica (Internat.), Vol. 10, No. 2, 87-91 (1960).

The just audible thresholds for the second to eighth harmonics in the presence of the first harmonic (357 c/s) of varying intensity level up to 76 dB re 0.0002 μbar, were determined. The results are in accord with those of Newman, Stevens and Davis (1937) but not with those of Janovsky (1929) and of von Braunmühl and Weber (19

9227 THE DECAY OF THE AUDITORY THRESHOLD AFTER THE SWITCHING-OFF OF WHITE NOISE. H.J.Stein.
Acustica (Internat.), Vol. 10, No. 2, 116-19 (1960). In German.

A suitable technique is described for measuring the behaviour of the ear after the cessation of a sound impulse. Results of experiments with broad-band noise are given and discussed.

9228 BRITISH NORMAL THRESHOLD OF HEARING. L.S.Whittle and D.W.Robinson.
Nature (GB), Vol. 189, 617-18 (Feb. 25, 1961).

Provisional data for the equivalent normal threshold sound pressures corresponding to the British Standard threshold of hearing are presented for a few of the earphone patterns in common use. This was determined by loudness balancing against a standard earphone of the reference pattern, by measurements of the British Standard artificial ear and the 9A coupler, and by comparisons of the new American and British Standard threshold data. An estimate is made of the intrinsic differences between the British Standard threshold of hearing and the two American values.

H.D.Parbrook

Vision

SIGNAL GENERATOR FOR USE IN VISUAL EXPERIMENTS
See Abstr. 4451

9229 MAXIMUM VALUE OF THE PHOTOMETRIC EQUIVALENT OF RADIATION FOR SCOTOPIC VISION.
J.Krochmann.
Lichttechnik (Germany), Vol. 13, No. 3, 102-5 (March, 1961). In German.

Using the current values of the radiation constants and the definition of the candela, the relative luminous efficiency of radiation is, for photopic (light-adapted, or cone) vision, 680 lm/W. For scotopic (dark-adapted, or rod) vision the value depends on how the unit of luminous intensity is related to the photopic candela. The C.I.E. has recommended that the definition of the candela should be the same for both conditions. This gives a scotopic efficiency of 1746 scotopic lm/W. Other proposals have been made and the author discusses their advantages and disadvantages in practice and gives the scotopic efficiency on each basis. J.W.T.Walsh

9230 ANALYSIS OF WALD'S DATA ON DARK ADAPTATION.
C.S.Bridgman.
J. Opt. Soc. Amer., Vol. 51, No. 2, 240-1 (Feb., 1961).

Wald's interpretation of his experiments on absolute threshold (Abstr. 12225 of 1960) is criticized. R.A.Weale

9231 PARTICIPATION OF RODS AND CONES IN VISUAL RESPONSES (REPLY TO THE COMMENTS OF C.S.BRIDGMAN). G.Wald.
J. Opt. Soc. Amer., Vol. 51, No. 2, 241-3 (Feb., 1961).

9232 LIGHT ADAPTATION AND THE BRIGHTNESS OF BRIEF FOVEAL STIMULI. J.W.Onley.
J. Opt. Soc. Amer., Vol. 51, No. 6, 667-73 (June, 1961).

Brightness scales for differing conditions of adaptation and contrast were established by the combined procedures of ratio production and equal-brightness judgments under adapting conditions which differ systematically for the two eyes. Under stimulus conditions in which light adaptation alone is systematically varied, the equivalence of brightness ratios at differing levels of adaptation is demonstrated for a wide range of adapting luminance. Preliminary findings suggest that this equivalence also holds for chromatic adapting and test stimuli. Changes in the brightness of brief foveal stimuli due to light adaptation may be describable within the framework of a general power law, if all test-stimulus lumin-

are expressed as luminance above psychological zero bright- (that is, as luminance above threshold for each specific condi- Changes in brightness due to light adaptation may be meas- either by the use of a preadapting stimulus or by presentation t stimuli on a prevailing surround. When adaptation is defined rms of the production of a criterion luminance threshold, the ive effects of the two procedures may be shown to be equivalent.

9233 ROLE OF INVOLUNTARY EYE MOVEMENTS IN STEREOSCOPIC ACUITY.
Shortess and J.Krauskopf.
pt. Soc. Amer., Vol. 51, No. 5, 555-9 (May, 1961).
Involuntary eye movements have been suggested as the basis for esolution of the small differences in visual angles which have reliably found in stereoscopic acuity determinations. By the f the stabilized image technique it is possible to compensate ally for the effects of these movements, so that the image ains on the same set of receptors. An optical apparatus was tructed in which the images presented to both eyes were lized. Stereoscopic thresholds were obtained for three subjects r both normal and stabilized viewing conditions for exposure s from 0.02 to 1.00 sec. Thresholds obtained under both itions decrease with an increase in exposure time with no ficant difference in the rate of decrease. This conclusion is istent with static theoretical concepts but conflicts with a mic theory of stereoscopic acuity.

9234 NOMOGRAPHIC SOLUTION OF THE FORMULA FOR THE RANGE OF LIGHT SIGNALS. W.Adrian.
ttechnik (Germany), Vol. 13, No. 3, 100-2 (March, 1961).
erman.
The formula giving the range of visibility of a signal (t) in s of its intensity (I), the atmospheric transmission (σ) and hreshold of perception (E_{min}) is $t^2 = I\sigma^t/E_{min}$, awkward for ct calculation. The author shows how to construct an alignment t for the ready determination of t, given the other variables. depends on the state of adaptation of the eye, i.e. it is a func- of the general field luminance, and allowance for this is ded in the diagram. J.W.T.Walsh

SPECTACLE LENSES WITH A REFRACTIVE POWER GRAD- . See Abstr. 4435

9235 THE EYE, THE BRAIN AND LAND'S TWO-COLOUR PROJECTIONS. W.A.H.Rushton.
re (GB), Vol. 189, 440-2 (Feb. 11, 1961).
A few qualitative experiments involving binocular colour matching illustrating the erroneous nature of the deductions Land drew from his experiments (Abstr. 10458 of 1959). R.A.Weale

9236 ELECTRICAL RESPONSES OF THE HUMAN EYE TO COLORED FLICKERING LIGHT. A.M.Granda.
J. Opt. Soc. Amer., Vol. 51, No. 6, 648-54 (June, 1961).
The electrical flicker responses to stimulation at various wavelengths and luminances were recorded by means of a frequency analyser in a manner suggested by Granit and Wirth [Journal of Physiology (GB), Vol. 122, 386 (1953)]. This instrument employs a tuned circuit to "lock-in" on the stimulating frequency of the light flashes. Its tuning characteristics allow it to reject frequencies other than the one to which it is tuned, thus improving the signal-to-noise ratio. The results obtained were plotted against stimulus luminance, and criterion responses were used to plot spectral sensitivity points as a basis for comparison with a standard phototopic sensitivity curve. The results point to the electrical responses of the eye as being more sensitive in the blue and red regions of the visible spectrum than their counterpart in psychophysical data. Various discrepancies and their possible sources are discussed. The use of the frequency analyser in further electroretinographic research is evaluated, particularly with problems that depend on some frequency characteristic of the response.

9237 COLOR-ORDER SYSTEM PREDICTING CONSTANT HUE. F.W.Billmeyer, Jr, J.K.Beasley and J.A.Sheldon.
J. Opt. Soc. Amer., Vol. 51, No. 6, 656-66 (June, 1961).
An Adjusted-hue colour order system was devised by combining the hue and chroma functions of Moon and Spencer's ω space, the Munsell value function, and the hue spacing recommended at Munsell 6/6 by the OSA Committee on Uniform Colour Scales. Adjusted-hue coordinates are related to CIE tristimulus values by equations which are conveniently solved on a digital computer. The hue coordinate Ω-H of the Adjusted-hue system correlates well with Munsell hue for colours within the gamut of the original Munsell Book. In the Munsell-renotation extrapolation region, however, lines in CIE space of constant Ω-H and constant Munsell-renotation hue are significantly different functions of value and chroma. Experiments with high-chroma transparent specimens in an acrylic resin suggest that Ω-H is a better approximation to visually perceived hue than is Munsell-renotation hue in regions where the two disagree. As expected, adoption of the Committee hue spacing results leads to better correlation of visual estimates of hue difference with differences in Ω-H than with differences in Munsell-renotation hue. However, a still more drastic readjustment of the Munsell hue spacing might further improve the correlation.

TECHNIQUE . MATERIALS

9238 PROGRESS IN NON-DESTRUCTIVE TESTING, VOLUME 1.
Edited by E.G.Stanford and J.H.Fearon. London: Heywood (1958) 267 + vii pp.

The first in an annual series of reviews which aims to record progress in non-destructive testing, by reporting work that may lead to new testing techniques or to the improvement of existing methods. It contains 8 review articles, a foreword and a short index. Abstracts of some of the papers will be found in this or succeeding issues of Physics Abstracts. J.B.Birks

9239 PROGRESS IN NON-DESTRUCTIVE TESTING, VOLUME 2.
Edited by E.G.Stanford and J.H.Fearon.
London: Heywood (1960) 250 + vii pp.

Contains 7 review articles and foreword. Abstracts of some of the papers will be found in this or succeeding issues of Physics Abstracts. J.B.Birks

THE STRUCTURE OF NON-DESTRUCTIVE TESTING.
See Abstr. 6065

9240 TECHNIQUE FOR THE RAPID, ACCURATE AND STRAIN-FREE MACHINING OF METALLIC SINGLE CRYSTALS. M.Cole, I.A.Bucklow and C.W.B.Grigson.
Brit. J. appl. Phys., Vol. 12, No. 6, 296-7 (June, 1961).

Spark planing, a new spark erosion method for the production of flat smooth metal surfaces, is described and its application to single metal crystals and to metallographic preparation is illustrated. The use of conventional spark erosion methods for crystal cutting and forming is also described. The spark planing technique is far more rapid and accurate than chemical or electrochemical machining and it causes very much less damage to the surface than the most careful grinding operation. Spark planed surfaces were examined by X-ray diffraction, reflection electron microscopy and a Talysurf tracer: these results are presented and the nature and extent of surface damage to various metals discussed.

9241 THE INFLUENCE OF THE MECHANICAL PROPERTIES OF A SOLID ON THE RATE OF ULTRASONIC MACHINING. N.M.Rostovtsev and G.I.Epifanov.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 4, 807-9 (Feb. 1, 1961). In Russian.

The influence of the pasticity and hardness upon the rate of ultrasonic-machining is investigated for various solids. It is found that the more plastic a solid the slower is the rate of machining. A comparison of the properties of hardened and unhardened steel shows little variation in the rate of processing, as the change in plasticity is offset by the change in hardness. An investigation of various lead–antimony alloys shows that the rate of machining is kept low by the presence of even slight plasticity but rises sharply as the plasticity vanishes. [English translation in: Soviet Physics—Doklady (USA)]. K.G.Majc

9242 ELECTRON MICROSCOPY AND AUTORADIOGRAPHY L.A.George, II.
Science (USA), Vol. 133, 1423-4 (May 5, 1961).

The combined techniques of electron microscopy and autoradiography were used for the purpose of differentiating radioactive fro nonradioactive particles collected on membrane filters. Newer methods of processing the membrane filters and applying the nucle emulsion have resulted in an improvement in the qualitative natur of the procedure.

PHOTOGRAPHIC TECHNIQUE FOR THE DETERMINATION OF METAL CUTTING TEMPERATURES. See Abstr. 6969

ELECTROLYTIC CUTTING OF THIN METAL FOILS FROM ORDINARY TENSILE SPECIMENS. See Abstr. 7897

A VERSATILE METAL TO DIELECTRIC SEAL. See Abstr. 5311

NEW METHOD FOR SEALING INFRARED WINDOW MATERIALS TO GLASS. See Abstr. 5347

LIQUID NITROGEN FEEDING OF A MASS SPECTROGRAPH TRAP. See Abstr. 5314

HALIDE LEAK DETECTOR FOR TESTING OVERPRESSURE EQUIPMENT. See Abstr. 4392

CONSTRUCTION OF THERMOPILES FROM FINE WIRE.
See Abstr. 7680

LIST OF JOURNALS

Appl. Math. Mech. (GB)
Applied Mathematics and Mechanics — Pergamon Press, Headington Hill Hall, Oxford; 122 East 55th Street, New York 22, N.Y. [A translation of: Prikladnaya Matematika i Mekhanika].

ISI Bull. (India)
ISI Bulletin — Indian Standards Institution, Manak Bhavan, 9 Mathura Road, New Delhi 1.

Phil. Sci. (USA)
Philosophy of Science — The Philosophy of Science Association. Publishers: Williams and Wilkins, 28 East Preston Street, Maryland, USA.

Vision Res. (GB)
Vision Research — Pergamon Press, Headington Hill Hall, Oxford; 122 East 55th Street, New York 22, N.Y. Vol. 1, No. 1-2, dated June, 1961.

ERRATA

or Index (1959) p. 1525, col. 1: for "D.G.Whitfield" read "G.D.Whitfield"
r. 12785 (1959) line 2: for "D.G.Whitfield" read "G.D.Whitfield"
or Index (Oct., 1960): for "LeBlanc,O.H., 15997" read "LeBlanc,O.H., Jr, 15738, 15997"
r. 5228 (1960) line 4: for "No. 37" read "No. 36"
r. 7464 (1960): insert journal reference: Phys. Rev. Letters, Vol. 4, No. 4, 181-2 (Feb. 15, 1960).
line 4: insert "γ" before "-radiation"
r. 8570 (1960) line 1: for "FEYMAN" read "FEYNMAN"
r. 8666 (1960) line 4: for "C.L.van P.van Eck" read "C.L.van Panthaleon van Eck"

Abstr. 3675 (1961) line 11: delete "English translation in: Soviet Physics—Doklady (USA)"
Abstr. 5456 (1961) line 4: for "Ya.F.Volkob" read "Ya.F.Volkov"
Abstr. 6827 (1961) line 2: for "FLUID" read "LIQUID"
Abstr. 6833 (1961) line 16: for "section" read "selection"
Abstr. 7030 (1961) line 3: for "Brifford" read "Briffod"
line 6: for "10^{-} A" read "10^{-15} A"
Abstr. 7454 (1961) line 5: for $(|\delta\psi_V,\psi_Y,,dr|^2)$ read $(|\int\psi_V,\psi_Y,,dr|)^2$
Abstr. 8473 (1961) line 6: for "ν −A theory" read "V−A theory"
Abstr. 8493 (1961) line 9: for "τ = 0 state" read "I = 0 state"

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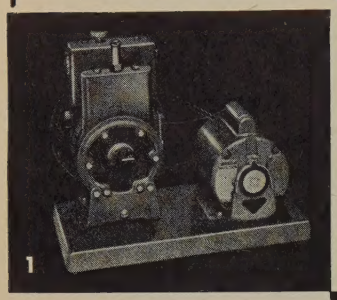

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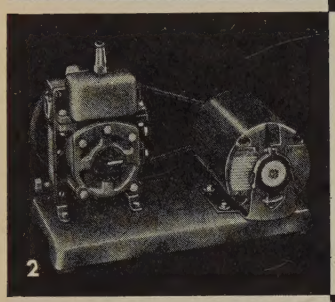

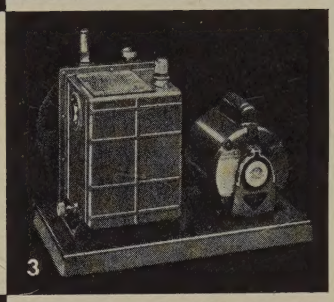

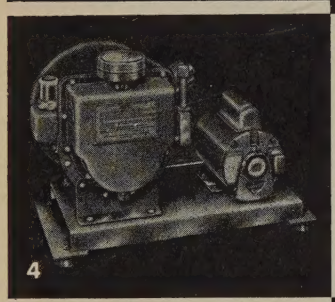

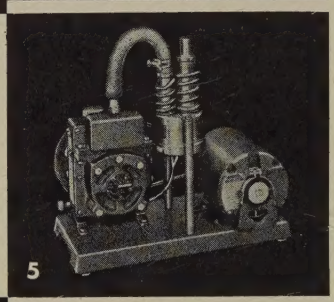

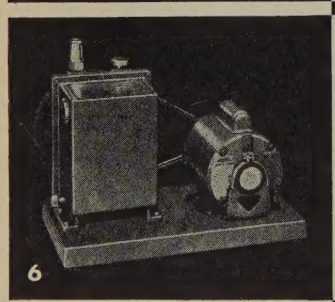

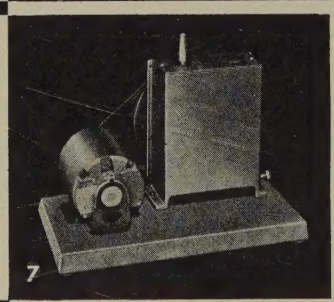

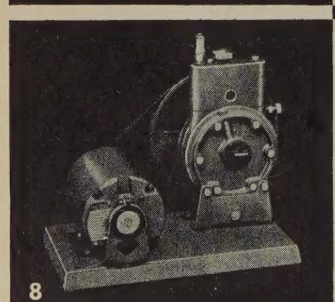

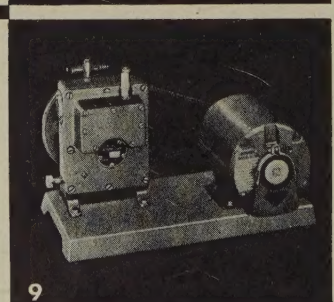

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